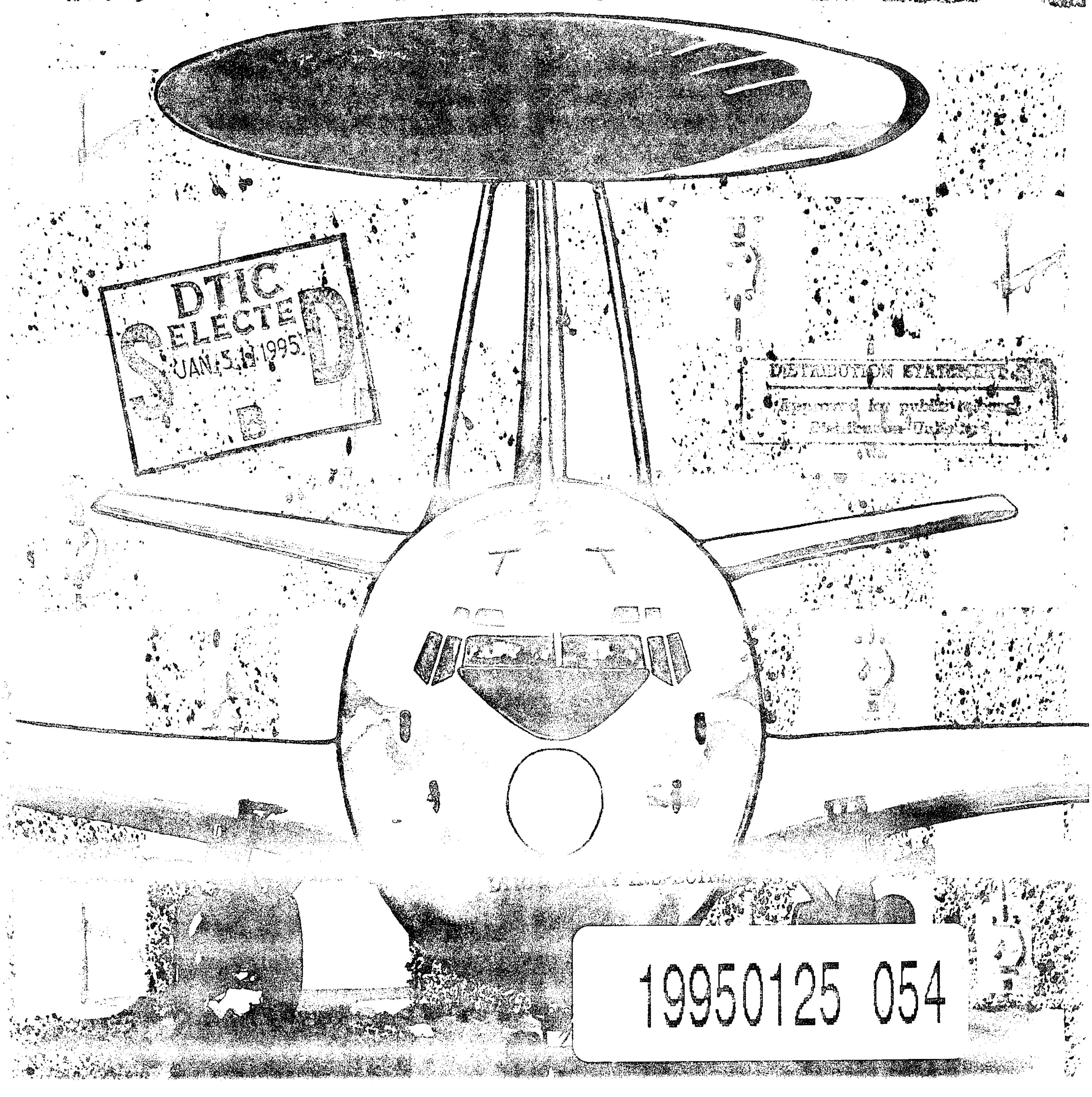
NEAR-REAL-TIME INTELLIGENCE
ON THE TACTICAL BATTLEFIELD

By James P. Marshall, Maj, USAF



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Near-Real-Time Intelligence on the Tactical Battlefield

The Requirement for a Combat Information System

by

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Foreword

Timely intelligence has always been a requirement for the effective use of air power. Air Force doctrine and the Army's AirLand Operations doctrine recognize the need for faster and more accurate intelligence to support the unprecedented pace of modern warfare. In the future, we may support operations throughout the spectrum of conflict against a foe, using a combination of equipment, doctrine, and tactics acquired throughout the world.

Maj James P. Marshall's research has come at an opportune time, with the reorganization of the United States Air Force and the creation of the Air Force Intelligence Command as a focal point for intelligence support to air combat operations. Past service rivalries and independent development of systems have led to a hodgepodge of collection, analysis, and dissemination systems. The intelligence challenge for the future is to present the tremendous volume of information that is collected to the right person, in the right format, at the right time.

Major Marshall provides outstanding insights into the historical causes of today's intelligence shortfalls and the technical and procedural problems we must overcome. He also proposes a combat information system that encompasses operations and intelligence information. The greatest value of Major Marshall's study is his combining current and near-term programs into a synergistic system that does not require major new acquisitions in a time of fiscal rollbacks. These initial steps will help ensure that intelligence systems and organizations in the future are not stovepiped, but enjoy greater joint service commonality and compatibility than ever before.

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Maj James P. Marshall

Maj James P. ("Jim") Marshall conducted this study while serving as the Air Force Intelligence Command-sponsored research fellow at the Air University College of Aerospace Doctrine, Research, and Education (CADRE), Maxwell Air Force Base (AFB), Alabama. He is a 1975 graduate of the United States Air Force Academy and received his masters of business administration from Golden Gate University in 1980.

Major Marshall is a senior navigator and electronic warfare officer with more than 1,400 hours of flying time in F-105G, F-4E, and F-4G aircraft at George AFB, California, and Clark AB, Republic of the Philippines. While at Clark, he served as the executive officer for the deputy commander for operations and on the wing commander's special projects staff.

In 1985, he began serving as chief of the Exercise and Training Branch and chief of the Simulator Validation Division at the Air Force Electronic Warfare Center. In 1988, he was selected to command the Electronic Security Command detachment at Eglin AFB, Florida. That detachment supports operational test and evaluation programs, exercises, and training at the USAF Tactical Air Warfare Center. He also was instrumental in establishing support to the newly formed Air Force Special Operations Command and other joint test and evaluation programs in the Eglin/Hurlburt area. Major Marshall is currently assigned to the Space and Advanced Programs Directorate at Headquarters Air Force Intelligence Command, Kelly AFB, Texas. He, his wife Emily, their son Nick, and daughter Kelly currently live in San Antonio, Texas.

Preface

> *History is not kind to nations that go to sleep. Pearl Harbor woke us up and we managed to win, although we are already forgetting the dark days when victory was uncertain, when it looked as though the scales might be tipped the other way.*
>
> —Gen George C. Kenney, 1950

The Air Force is facing incredible changes in the world political order and the threat we face. The Air Force also faces many changes in its organizational structure and from the tremendous technological boom in communications and weapon systems. While the threat of nuclear holocaust as a result of a confrontation between the United States and the Confederation of Independent States (formerly the Soviet Union) has diminished, the increased lethality of weapon systems and the proliferation of advanced weapons of mass destruction among third world countries demand that we maintain the capability and flexibility to deal with regional conflicts around the world. As President George Bush stated immediately following the Iraqi invasion of Kuwait in August 1990:

> Notwithstanding the alteration of the Soviet threat, the world remains a dangerous place with serious threats to important U.S. interests wholly unrelated to earlier patterns of the US-Soviet relationship. . . . These threats . . . can arise suddenly, unpredictably, and from unexpected quarters. U.S. interests can only be protected with a capability which is in existence, and which is ready to act without delay.[1]

In many ways the increased proliferation of sophisticated weapon systems and the pullback of US forces from overseas locations may increase the likelihood of the US military being called on to intervene on behalf of US interests around the world.[2] As Gen John W. Foss pointed out, the future of military operations is in tailoring the right force package to the threat and being able to respond in a short period of time.[3] Maj Gen Richard J. O'Lear, US Air Force assistant chief of staff, Intelligence, emphasized that:

> conducting effective Air Force intelligence operations in a rapidly changing political, economic, military, and technological environment presents a stern challenge to all intelligence organizations and personnel. Intelligence must learn from the past, adjust to the changing operational needs of today, and plan to meet the intelligence requirements of tomorrow.[4]

This monograph traces the historical trends in attempting to provide near-real-time intelligence to the tactical war fighter and evaluates some of the technical and procedural problems associated with providing near-real-time intelligence. It also provides a focus for development of an intelligence architecture that has utility across the entire spectrum of conflict.

The reunification of strategic and tactical air power into "combat" air power is under way, and many of the names and much of the terminology relating to what the military previously considered "tactical" or "strategic" air power is changing. I have

made every effort to address current doctrine, weapon systems, and organizations, but they are elusive targets in many cases. In the case of the Tactical Air Control System and its related organizations, this study uses the old terms because the Air Force has not published the final approved new names as of this writing.

Notes

1. *Triumph Without Victory: The Unreported History of the Persian Gulf Conflict,* ed. by the staff of *U.S. News & World Report* (New York: Times Books, 1992), 60.

2. Lt Col Robert J. Blunden, Jr., *Tailoring the Tactical Air Control System for Smaller Scale Contingencies* (Maxwell AFB, Ala.: Air University Press, 1992), 1.

3. Ibid.

4. Air Force Manual (AFM) 3-1, "Air Force Functional Doctrine for Aerospace Intelligence Operations" (Draft), March 1992, 2.

Chapter 1

Doctrine

What is called "foreknowledge" cannot be elicited from spirits, nor from gods, nor by analogy with past events, nor from calculations. It must be obtained from men who know the enemy situation.

—Sun Tzu, Fourth Century B.C.

Military actions taken during the Persian Gulf War and other military contingencies of the last 20 years show the pace and intensity of war as well as the geographic areas of interest to an operational commander have grown tremendously. In view of advances in technology and the accelerated speed of modern warfare, there is an increased demand and operational capability for near-real-time intelligence or, more accurately, combat information support on the tactical battlefield.

The acquisition of timely and accurate intelligence or combat information is basic to all Air Force, and indeed all, combat operations. According to Air Force Manual (AFM) 1-1, *Basic Aerospace Doctrine of the United States Air Force:*

> The effective and efficient use of aerospace forces depends greatly upon accurate and timely intelligence assessment. Throughout strategic and tactical actions, there is a constant demand for detailed and timely intelligence about the enemy and his military forces. Aerospace forces have a unique capacity, far beyond the scope of surface forces, to acquire intelligence information. An intelligence system must acquire, process, and dispatch information gained from a variety of sources *in time for decision makers to assess what needs to be done and take appropriate actions* [emphasis added]. Useful, timely intelligence prevents surprise and enhances opportunities to seize the initiative.[1]

There is a fundamental difference between intelligence and combat information. *Intelligence* comes from multiple sources (all-source), is frequently highly classified, covers large geographic areas, and is used to determine orders of battle and enemy intent. *Combat information* or raw intelligence, is more focused to a particular geographic area or target, is sanitized to a usable classification, and is provided without time delays for analysis. The largest drawback of combat information is its dependence on fewer sensors without the opportunity to correlate and analyze the information.[2] The amount of intelligence and combat information available today is unprecedented, but often the operations/intelligence system fails to get this information to the decision makers and combatants in a timely manner.

Gen Charles A. Gabriel, while serving as the Air Force deputy chief of staff for plans and readiness, wrote that US and North Atlantic Treaty Organization

(NATO) forces would likely fight in what is often euphemistically referred to as a "target rich" environment if there were a conventional conflict in Central Europe. Although some people think this reference to the overwhelming numerical superiority of Warsaw Pact and Soviet forces means that there is less need for reconnaissance acquisition systems, quite the opposite is true. Moreover, despite dragoons on both sides, we can expect to enter such future conflicts outnumbered. As General Gabriel concluded, "In future conflicts, our weapons must be employed selectively and with precision because we are force limited."[3] Gen Hans-Henning von Sandrart, commander in chief Allied Forces Central Europe, agreed, and added that the problem is not that we may not get enough information, but whether all the systems that the nations have bought can be integrated into one comprehensive system.[4]

Intelligence Principles

The Air Force must evaluate all intelligence systems against a series of principles espoused in draft AFM 3-1, "Air Force Functional Doctrine for Aerospace Intelligence Operations" (table 1). The first principle is *accuracy*. Because of our own predispositions, human error, and the fog of war, no intelligence estimate can be 100 percent accurate. Commanders and operations personnel should not expect an estimate to be 100 percent accurate.

Table 1

Aerospace Intelligence Principles

1. Accuracy	7. Completeness
2. Timeliness	8. Readiness
3. Objectives	9. Fusion
4. Cooperation	10. Perceptiveness
5. Relevance	11. Security
6. Usability	12. Flexibility

According to draft AFM 3-1:

> Uncertainty is proportionate to the complexity of the issue, sophistication of the enemy systems, the amount of detail required, and our own collection and analytical capabilities. The length of time available to collect information and its perishableness also affects accuracy.[5]

Because we cannot achieve certainty with our intelligence estimates, intelligence must indicate the confidence level in the information provided and ensure that the commander understands the uncertainties.

The requirement for accuracy must be balanced with the second principle, that of *timeliness*. Again, as stated in draft AFM 3-1:

> Intelligence that would influence an operation or program is worthless if the commander receives it after the opportunity has passed, an irreversible decision has been made, or an operation is completed.[6]

This principle more than any of the others has been influenced by the explosion of technology in both collection capabilities and dissemination systems.

The principle of timeliness ties in closely with the principle of *objectives,* for the intelligence system must be closely tied to the commander's objectives if it is to provide timely support. This principle requires that intelligence requirements, organizations, and dissemination systems be based on the commander's objectives. Data presented must relate to the commander's stated goals and not be merely a statistical listing of enemy capabilities. A complete understanding of the commander's intentions as expressed through the commander's guidance to staff and subordinates and through the allocation and apportionment process is critical. Too often this guidance is not passed to the collectors and analysts. Also, analysts and collectors too often do not seek the commander's guidance. Commanders and their staffs must push their objectives down, and the collectors and analysts need to pull them down. Failure to follow the principle of objectives results in misallocation of intelligence assets.[7]

The next principle is *cooperation.* This applies both to interservice cooperation to support the overall campaign objectives and to the cooperation of the various intelligence disciplines within the Air Force. We must be able to cross-cue sensors to optimize target coverage, eliminate duplication, and avoid deception.[8] Individually, sensors can be deceived. The enemy can line up decoy aircraft on runways, broadcast false communications, and generate false electronic signals, but by using one sensor to focus another kind of sensor on the target area, we can prevent being fooled by one type of deception.

The principle of *relevance* requires that intelligence information applies to the situation and is appropriate to the level of command. It should add to the understanding of the situation and directly support planned and current operations and not be merely a statistical listing of enemy capabilities.[9]

The principle of *usability* refers to the requirement to disseminate intelligence information to the consumer in a form that does not require any additional processing or analysis. The commander, planner, or war fighter should be able to use the information in its delivered form. Standardization of terminology and displays helps ensure that the product is usable.[10]

The principle of *completeness* stresses that the commander should have all available, relevant information required to accomplish his objectives. Collection and production priorities should ensure that intelligence gaps are filled.[11]

The principle of *readiness* states that intelligence organizations, data bases, and end products must be responsive to current and potential requirements of commanders and their staffs. A continual criticism over the years has been that the intelligence system has taken too long to spin up in response to crises. This problem continues as a significant challenge as limited collection resources require that intelligence personnel accurately forecast potential trouble spots throughout the world far enough in advance to establish a comprehensive data base of enemy capabilities.[12]

The principle of *fusion* offsets the inherent weaknesses of individual collection systems and the camouflage and deception efforts of the enemy. To overcome these problems, information from a variety of sources is combined and analyzed to produce an all-source fused intelligence product. The principle of fusion is often at odds with the principle of timeliness in that no matter how automated, the process of fusing intelligence takes time. The time difference between real-time and near-real-time intelligence is a function of this fusion process. Fusion is not always required. Often, a near-real-time correlation or comparison of data is sufficient. Combat information that is sufficiently important or complete can be used immediately, but with the knowledge of the dangers of relying on a single source of information that may be incomplete, inaccurate, or the result of a ruse or deception.[13]

The principle of *perceptiveness* deals with "doing your homework" before the outbreak of hostilities. According to draft AFM 3-1, "extensive knowledge of enemy strategy, tactics, doctrine mentality, and behavior patterns . . . provides insights into the enemy's plans and likely courses of action."[14] A comprehensive knowledge of the enemy allows the analyst to make more rapid, accurate assessments based on limited information.

The principle of *security* applies to physically protecting our own capabilities and intentions and safeguarding lucrative sources of intelligence. By judicious use of the need-to-know principle and multilevel secure communications, intelligence personnel can keep commanders and other consumers informed without putting sources at undue risk.[15]

Finally, the principle of *flexibility* demands that the intelligence system does not depend totally on one type of intelligence, one means of intelligence production, or one means of disseminating critical intelligence. The system must not have a single critical node that, when destroyed or disrupted, causes a substantial breakdown of the entire system. This flexibility requirement demands that everyone in the process, from collection to processing to dissemination, be aware of the commander's overall objectives so that a single point failure will not totally interrupt the flow of information.[16]

These principles of intelligence provide the basis for support to the air component commander and projection of air power. Air power is only one of the commander in chief's weapons and must fully integrate with the ground component to achieve the optimum results. This integration of air and land power is achieved through what the Army calls the AirLand Battle doctrine and its follow-on—AirLand Operations.

AirLand Battle Doctrine and AirLand Operations

The AirLand Battle doctrine of 1986 was the Army's vision of how future wars will be fought. It emphasized initiative, depth, agility, and synchronization in fighting on a nonlinear battlefield. According to military analyst Charles Christopher:

> This AirLand Battle Concept also has implications for other US military services, most notably the Air Force. Stressing the importance of force synchronization and the integral part played by the other military services, AirLand Battle strives to ensure that all forms of combat power are brought to bear on the enemy in a mutually supportive, coordinated plan.[17]

Future battlefields will be fluid without traditional front lines or safe rear areas. As the operational echelon, the Army corps plans not only to fight the traditional close-in battle but also to fight in friendly and enemy rear areas. The focus will be on destruction of the enemy versus holding terrain, and the flanks and rear areas will become primary battlefields.

The Army developed this doctrine in response to, and to mirror in some ways, Soviet operational doctrine. The Soviets' doctrine requires that they achieve their objectives quickly before allied forces can employ nuclear weapons or internal pressures can develop to halt the Soviet attack. That is why the Soviets are organized into operational maneuver groups trained and equipped for a blitzkrieg type of warfare emphasizing surprise, speed, and firepower.[18] To counter this, US Army corps commanders prepare to conduct the battle in any part of their areas of influence. Commenting on Army doctrine of the twenty-first century, Charles Christopher noted:

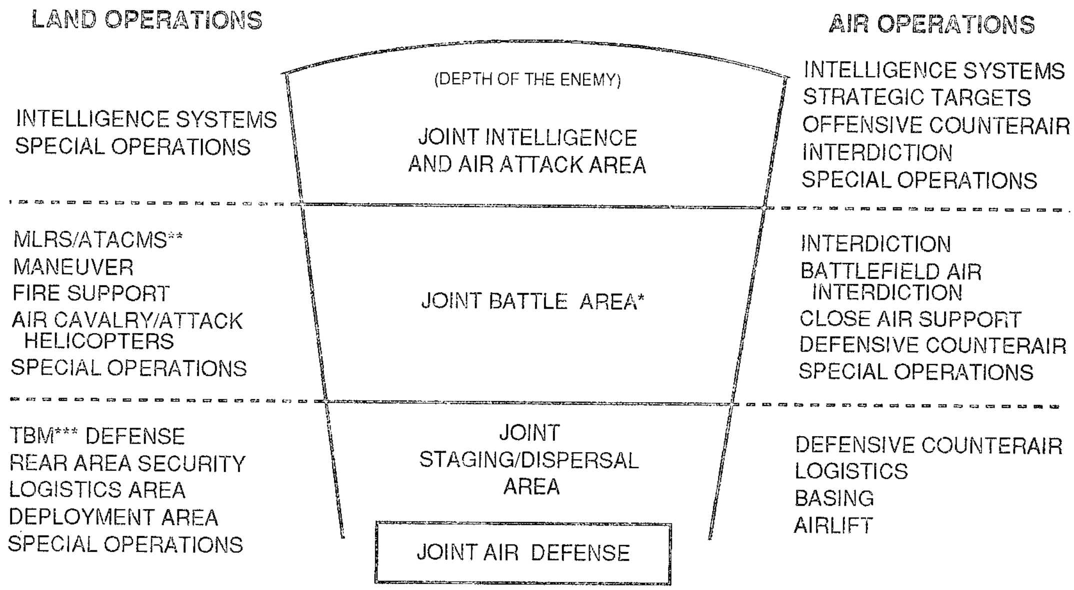
> While it is commendable and, needless to say, highly desirable to seize the offensive and prosecute the war as close to enemy territory as possible, the fact of the matter is that Soviet OMGs (Operational Maneuver Groups) will be, in all probability, deep in NATO territory and must be neutralized. . . . What forces should be used to attack OMGs? How should the battle be prosecuted given the blurring of friendly and enemy lines and *the inherent problems in locating, on a real time basis, the OMGs most critical elements* [emphasis added].[19]

AirLand Operations is an evolutionary concept that has grown out of the AirLand Battle doctrine and lessons learned from Desert Storm and other contingency operations of recent years. AirLand Operations projects the AirLand Battle doctrine into the twenty-first century recognizing that, while the nonlinear battlefield remains a valid possibility, traditional linear battles may still be fought in the future as well (fig. 1). The linear battlefield will divide into a joint staging/dispersal area, a joint battle area that the Army and Air Force will share, and a joint intelligence and air attack area that will be the arena for the Air Force and national systems.[20]

Initiative

The first tenet of the AirLand Battle doctrine is initiative. *Initiative* is dictating when and where battles will be fought. Initiative is equally applicable to offense or defense and implies a willingness to take risks.[21]

To seize the initiative, the commander must have near-real-time intelligence to get inside his opponent's decision cycle and make the enemy react to our plan. This is especially important when fighting an enemy using an operational maneuver group concept because the longer it takes to locate and engage the enemy, the more time the enemy has to carry out his mission.[22] British strategist Maj Gen J. F. C. Fuller pointed out that "he who can move twice as



*The joint battle area is where Army forces fight to the depth of all their weapon systems and where Army and Air Force capabilities overlap. Here we must emphasize the development of joint tactics, techniques, and procedures.
**Multiple launch rocket system/Army tactical missile system.
***Tactical ballistic missile.

Source: TRADOC Pamphlet 525-5, *AirLand Operations,* 1 August 1991.

Figure 1. Theater Campaign Plan—AirLand Operations

fast as his opponent doubles his operative time and thereby halves that of his opponent."[23]

Agility

The second tenet of the AirLand Battle is *agility* or the ability to act faster than the enemy. This ability is essential to seizing and holding the initiative.[24] Agility, again, is an Air Force strong point. The ability to mass firepower in different locations throughout the theater from day to day or even mission to mission is uniquely an Air Force capability. Even the highly mobile air cavalry and armor of a modern army cannot match air power in its ability to move firepower to where it is needed.

A key factor in maintaining agility is having a command, control, communications, and intelligence (C^3I) system that is faster, more flexible, and more robust than the enemy's. We must be able to degrade the enemy's command and control system while protecting our own. This is an increasingly difficult problem as Soviet radio-electronic combat capabilities become more effective.[25]

Depth

Army Field Manual (FM) 100-5, *Operations,* states that "through the use of depth, a commander obtains the necessary space to maneuver effectively; the

necessary time to plan, arrange, and execute operations."[26] The concept of fighting a deep battle became feasible after the development of new sensors that can "look deep" and the development of new weapon systems that can hit those targets. Gen William E. DePuy, former commander of the Army Training and Doctrine Command (TRADOC), stated:

> The first thing we really need to know is where that attack is going to take place. That is one of the first areas where we are dependent on the Air Force. . . . We need to see back where the second and third echelon are, and we need to see back there before it [the enemy attack] happens.[27]

His successor, Gen Donn A. Starry, observed that finding the second echelon divisions and armies is so critical to the corps commanders that the Air Force must establish beyond doubt the timeliness of response to ground forces and extent of coverage of the air reconnaissance system.[28] The Army corps commander relies on USAF and national systems for "aerial reconnaissance and surveillance because he does not himself have the means to see the second echelon divisions or the second echelon army."[29] Most Army collection systems support the close-in battle and don't have the range to "see" enemy second echelon forces. A potential problem for the corps commanders is gaining access to the surveillance capabilities of the future battlefield when control of those assets is held at the theater or national level.

Although strategists generally agree on the necessity of attacking second echelon forces, according to Lt Col Price Bingham of the Airpower Research Institute, we tend to underestimate the problem of locating mobile forces. He explains that the first requirement for successful interdiction using direct attack conventional munitions is reliable, timely target information.[30]

While the Army has developed such new weapons for the deep battle as the Army tactical missile system, the nonnuclear Lance missile, and the multiple launch rocket system, the Air Force still has the majority of weapons with the capability to fight the deep battle. Gen Edward C. Meyer, Army chief of staff, described the Air Force role in the deep battle:

> Their mission is not just killing tanks. Their mission is also making certain that the reinforcing armored forces are either slowed or destroyed, and I say slowed, because slowed is equally important. If you are up in the front lines fighting and if you can keep the enemy from closing all of his forces on you at the same time, that is important to you.[31]

Air power is ideally suited to support this kind of warfare, but air power encounters new intelligence challenges. The Army recognizes these challenges and lists sensors and communications as two of the challenges the Army faces in fighting the AirLand Battle. FM 100-5 states:

> Wide ranging surveillance, target acquisition sensors, and communications that provide information almost immediately will increase the range and scope of the battle. Sensors offer the commander more than just timely information on deep enemy locations and activity. They also serve as the basis for attacking enemy follow-on forces. . . . Since these attacks can be of vital importance in battle, the sensors and communications means which make them possible are particularly valuable.[32]

Synchronization

The final tenet, *synchronization,* is a method of creating unity of effort to achieve the commander's objectives. In deep battle, synchronization includes not only the integration and concentration of actions by the air and land forces engaged behind the enemy lines but also synchronization of the deep battle with the close and rear battles to achieve a common goal.[33] Interdicting second and third echelon forces before the enemy can commit them to the battle will disrupt the enemy's timetable and decrease his ultimate effectiveness.[34] By countering ground maneuver, the enemy exposes himself to air interdiction, while protecting himself from interdiction leaves him vulnerable to ground maneuver.[35] Similarly, "although air interdiction can delay and disrupt an enemy's movement by destroying his forces, it can also have the same effect *if the enemy does not dare to move quickly for fear of being found*" (emphasis in original).[36] Air interdiction and ground maneuver must be synchronized so that each complements and reinforces the other, thus creating an unsolvable dilemma for the enemy. Traditionally, the ground commander is more interested in the effects of target destruction on the enemy's scheme of maneuver, while the Air Force tends to look at individual targets.

Our NATO allies have had a similar view of the future battlefield. The NATO term for the deep battle is *follow-on forces attack* (FOFA).

> FOFA is different from the [Air Force] interdiction concept as we have known it. . . . It is more time and space sensitive with respect to supporting the land commander's campaign plan and immediate battlefield needs.[37]

The joint development of deep target priorities requires that all forces focus their firepower on achieving the commander's objectives. The immediate targeting and destruction of perishable targets requires a C^3I system that allows acquisition, ranking, deconfliction, and targeting of second echelon forces.

The emerging strategy of NATO is based on the dissolution of the Warsaw Pact and former Soviet Union as a threat and the increasing likelihood of regional conflicts as typified by the number of ethnic confrontations occurring throughout Eastern Europe. This new strategy of crisis management has led NATO officials to modify the concept of FOFA into joint precision interdiction.[38] This strategy, to provide rapid support anywhere in the NATO theater and to conduct precision interdiction behind enemy lines, will continue to require a robust near-real-time reconnaissance/surveillance capability.

Summary

The desire for faster, more accurate information is not new. Timely, accurate intelligence is a cornerstone for both Air Force and Army doctrine and is absolutely essential to the AirLand Battle and the Army's new concept of AirLand Operations. The tenets of initiative, depth, agility, and synchronization remain valid. The reconnaissance/surveillance capability that air power

provides supports these tenets. The principles of Air Force intelligence stress the need for timely and accurate information. What has changed in recent years is both the capability and doctrinal requirement to see far beyond the front lines and to incorporate that vision on a near-real-time basis into targeting and planning information.

Notes

1. Air Force Manual (AFM) 1-1, *Basic Aerospace Doctrine of the United States Air Force,* 16 March 1984, 2-21. The Air University revised AFM 1-1 in March 1992. The new edition pays little attention to the importance of intelligence and makes only passing comments on the surveillance and reconnaissance missions.
2. A. R. Martorano, *Draft Preliminary Combat System Integrated Interoperability Requirements Document—Combat System Description* (Bedford, Mass.: Mitre Corporation, December 1984), 4.
3. Gen Charles A. Gabriel, "Tactical Reconnaissance for the 1980s," *Signal,* October 1979, 9.
4. Gabriel Ferenczy, "Battlefield Surveillance and Target Acquisition," *NATO's Sixteen Nations,* August 1989, 52.
5. AFM 3-1, "Air Force Functional Doctrine for Aerospace Intelligence Operations" (Draft), 15 March 1992, 16.
6. Ibid., 17.
7. Ibid., 18.
8. Ibid., 18–19.
9. Ibid., 19.
10. Ibid., 19–20.
11. Ibid., 20.
12. Ibid.
13. Ibid., 21.
14. Ibid., 21–22.
15. Ibid., 22–23.
16. Ibid., 24.
17. Charles Christopher, "AirLand Battle Doctrine—Into the 21st Century," *Military Technology,* September 1984, 59.
18. Ibid., 61.
19. Ibid., 65.
20. TRADOC Pam 525-5, *AirLand Operations,* 1 August 1991.
21. Army Field Manual (FM) 100-5, *Operations,* May 1986, 15.
22. Christopher, 65.
23. Quoted in Lt Col Charles M. Westenhoff, ed., *Military Airpower: The CADRE Digest of Air Power Opinions and Thoughts* (Maxwell AFB, Ala.: Air University Press, October 1990), 64.
24. FM 100-5, 16.
25. Christopher, 65.
26. FM 100-5, 16.
27. Quoted in Robert Frank Futrell, *Ideas, Concepts, Doctrine: Basic Thinking in the United States Air Force,* vol. 2, *1961–1984* (Maxwell AFB, Ala.: Air University Press, 1989), 548.
28. Ibid., 549.
29. Ibid.
30. Lt Col Price T. Bingham, *Air Power and the Defeat of a Warsaw Pact Offensive: Taking a Different Approach to Air Interdiction in NATO,* AU-ARI-CP-87-2 (Maxwell AFB, Ala.: Air University Press, March 1987), 3–4.
31. Futrell, 553.
32. FM 100-5, 3.
33. Lt Col William A. Walker, "The Deep Battle," *Army,* July 1986, 31.

34. Ibid., 30.

35. Lt Col Price T. Bingham, *Ground Maneuver and Air Interdiction in the Operational Art,* AU-ARI-CP-89-2 (Maxwell AFB, Ala.: Air University Press, September 1989), 2.

36. Ibid., 3.

37. Lt Col Thomas G. Runge, *Firepower and Follow-On Forces Attack: Making Every Round Count* (Maxwell AFB, Ala.: Air University Press, March 1991), 17.

38. Larry Grossman, "NATO's New Strategy," *Air Force Magazine* 75, no. 1 (March 1992): 26–29.

Chapter 2

Collection, Processing, and Dissemination

A general should neglect no means of gaining information of the enemy's movements and, for this purpose, should make use of reconnaissances, spies, bodies of light troops commanded by capable officers, signals, and questioning deserters and prisoners.

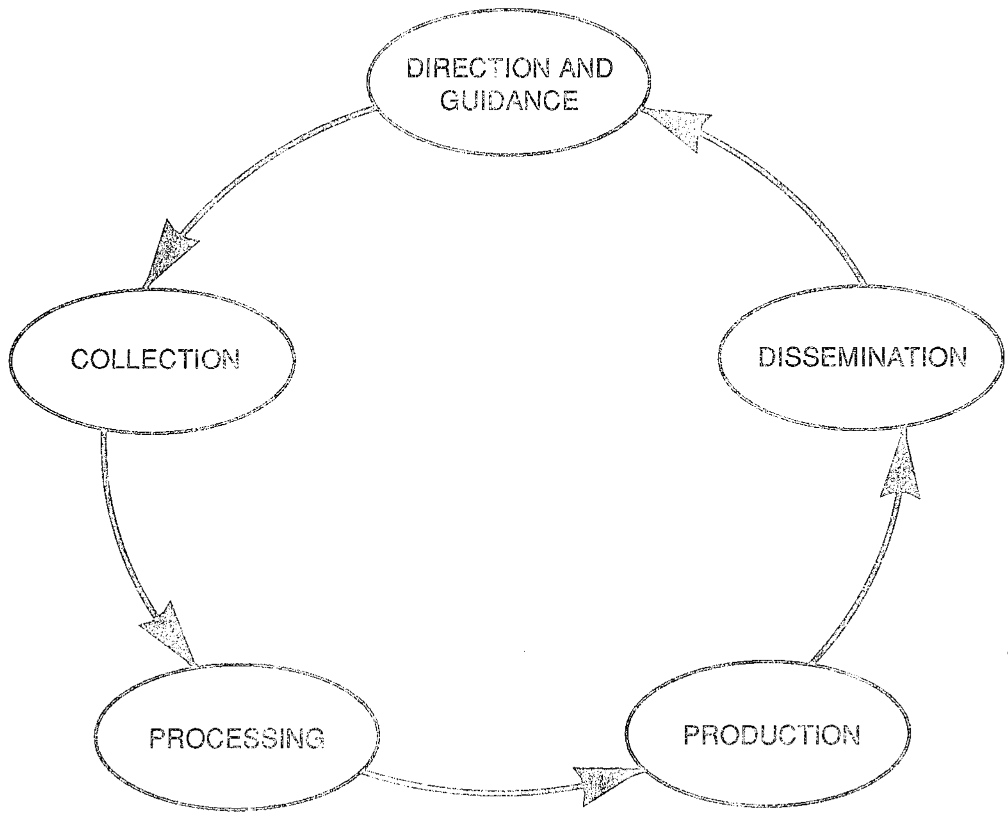
—Baron De Jomini
The Art of War

The intelligence cycle is a sequential, iterative process including the phases of direction, collection, processing, production, and dissemination (fig. 2). The first step of this process, direction, is based on the commander's guidance and strategic objectives. This is the basis for the development of the collection plan, tasking of various intelligence agencies and tactical collection platforms, and continuing feedback evaluation as to the appropriateness and effectiveness of the various collection systems.[1]

Input from the appropriate collection management office sets the priorities for what intelligence to collect and which systems to use, in both combat and peacetime. The collection management process transforms the commander's information needs into intelligence collection requirements and taskings and includes monitoring of collection activities. The process provides feedback to both the requestor and the collector. To be truly effective, the collection manager must be knowledgeable of intelligence disciplines, the capabilities of the various collection platforms, and of force development, deployment, and employment.[2]

Collection is the systematic acquisition of information through a variety of disciplines and technical means. Collection involves both passive (signals intelligence [SIGINT]) and active (human intelligence [HUMINT] and imagery intelligence [IMINT]) means of acquiring information. Intelligence and operations personnel are involved in collection efforts and report information derived from mission execution. Coordination of collection efforts among the various services and agencies allows cross-cueing of sensors and reduces duplication of effort.[3]

Most raw intelligence data requires processing before use. This includes film processing, signal processing, and communications and document translation. In the past, processing time has prevented the commander from having near-real-time intelligence information. The explosion of computing technology, electro-optics, and communications capabilities has cut down this processing phase tremendously for some intelligence products. The new draft AFM 3-1 states that data should be "processed and/or screened as quickly as possible."[4]



Source: AFM 3-1, "Air Force Functional Doctrine for Aerospace Intelligence Operations" (Draft), 15 March 1992, 8.

Figure 2. The Intelligence Cycle

This addition of the concept of screening data is in recognition of the increasing demand for near-real-time combat information.

During the production phase, intelligence analysts evaluate, analyze, integrate, and interpret the raw data. At this point, the experience and professional judgment of the analyst come into play. Much of the data gathered from the environment is not pertinent to the commander's objectives or is obviously inaccurate when compared with other information also arriving. Using a thorough knowledge of enemy strategy, tactics, equipment, doctrine, the current enemy situation, and the commander's objectives, an analyst can identify significant information that affects current operations as well as the overall objectives. Integration, or correlation, combines and compares information from different sources to avoid duplication, to enhance the overall picture, or to discount some pieces of information. Interpretation takes the collected intelligence, combines and compares it with previously gathered intelligence, and provides an assessment to the commander as to the significance of information already collected. The real measure of value to the commander is not

necessarily how much data has been collected, but its worth in planning and conducting operations.

The dissemination phase gets the information from the producer to the consumer. The intelligence producer must have a thorough knowledge of the intelligence requirements of the consumer, the format and media available for transmission, and the impact of the information on combat operations.[5] The consumer may be the commander formulating the campaign plan, the control elements of the Tactical Air Control System running the air war, or the aircrews and ground troops on the front line. Historically, many intelligence dissemination systems have focused on supporting the national command authorities (NCA), other intelligence agencies, and then the commander, with little emphasis on the lower echelons.

Surveillance versus Reconnaissance

The terms *surveillance* and *reconnaissance* are often used synonymously, but in reality they are quite different with respect to intelligence. *Reconnaissance* produces a "snapshot" view of the battlefield. Until recently, almost all combat intelligence has been based on reconnaissance. For example, RF-4s would fly over the target area to take photos, RC-135s would collect the electromagnetic environment for processing and updating electronic orders of battle, or Special Forces units would report on the status of a certain bridge or military facility. While each report may have been 100 percent accurate, it was only accurate for one moment in time—a time in the past.

Surveillance, on the other hand, reports on what is happening right now. It continuously monitors the situation as it unfolds. For example, during Operation Desert Storm the Joint Surveillance Target Attack Radar System (J-STARS) detected an Iraqi convoy of free-rocket-over-ground (FROG), surface-to-surface missiles fitted with chemical munitions. The Air Force immediately targeted the convoy and destroyed it with F-16s using cluster munitions.[6] Using unmanned aerial vehicles (UAV) launched from battleships and maneuvering ground units, the Navy and Marines spotted for battleship gunfire, identified targets, and gathered battle damage assessment information on a real-time basis.[7] Special Forces teams gathered intelligence on frontline Iraqi units and directed close air support and artillery fires.[8] The tactical electronic reconnaissance system on the RF-4 provided the capability to data link selected electronic order of battle information back to the headquarters, and the J-STARS provided near-real-time imagery to airborne controllers and ground stations. These systems provided continuous insight as to what was happening rather than a snapshot of a previous situation. Yet, despite the many successes of Desert Storm, a report released to Congress on the conduct of the war stated that "broad area, all-weather, search/surveillance systems are required to improve the intelligence available to the tactical commander."[9]

Other than the time differences, reconnaissance is used to develop tactical intelligence—that is, it goes through the processing phase of the intelligence cycle before it is available to the decision maker. There is also time to perform a more extensive evaluation of the information and fuse it with information from other sources. Combat information gathered during surveillance is generally from a single source and has not been compared with other sources. Users must remember that intelligence is evaluated data, while combat information is raw unevaluated data; and they must recognize the risks associated with using combat information versus fully developed combat intelligence. Information based on only one source is especially susceptible to deception.

Intelligence versus Targeting Systems

Air Force targeting is the intersection of intelligence and operations. It is the point where the commander's guidance and objectives come together with the threat, the target, and friendly capabilities and weapon system availability.[10] The Air Force views targeting as a product of intelligence analysis, whereas the Army views targeting as a real-time target selection process. The Army recognized the need for immediate access to all-source intelligence and created the combat electronic warfare and intelligence organizations to support commanders at all levels.[11]

The distinction between intelligence and targeting in both services is not merely a turf battle but a significant difference in mission. Normally intelligence collectors do not have training in directing force application. Their training, organizational structure, and communications systems provide information to the decision maker who directs forces against the enemy. Targeteers, on the other hand, are not normally as well versed in the collection management field. As military forces field more and more surveillance systems (as opposed to reconnaissance systems), such as UAVs and J-STARS, it is extremely important to develop concepts of operations that take full advantage of available near-real-time combat information to direct fires. During Desert Storm, aircrews composed of Air Force Systems Command pilots and navigators, contractors, and tactical air power experts developed concepts for employment of the J-STARS literally "on the fly" as the crews deployed to the desert.[12]

Types of Intelligence

Intelligence collectors use a wide variety of systems and intelligence disciplines to include signals intelligence, human intelligence, multisensor imagery intelligence, and other technical sensors. These disciplines each have their own particular strengths and weaknesses (table 2).

Table 2

Comparative Intelligence Capabilities

	IMINT	*SIGINT*	*HUMINT*
Accuracy	50–2,000 Feet	1–10 Miles	Inches–Miles
Timeliness	Hours–Days	Minutes–Hours	Days–Months
Detail	Inches–Feet	Emitter Type	Variable
Penetration	Night/Clouds	Night/Clouds	Inside Buildings

Source: Norman B. Nill, *Image Intelligence—Systems and Techniques,* ESD-TR-84-191 (Bedford, Mass.: Mitre Corp., 1984), 89.

Human Intelligence

Human intelligence comes from enemy prisoners of war, refugees, captured documents, and friendly guerrilla fighters as well as our own observation posts, patrols, and long-range surveillance units. While HUMINT can be an excellent single source of information, there are many drawbacks to its use in a tactical situation. HUMINT is not consistently available in all areas, assets are not very mobile, the reliability of foreign sources is difficult to assess, and with the exception of some long-range surveillance patrols, HUMINT is not particularly timely.[13]

This area is improving with the development of advanced optical systems, electronics, and communications technologies.[14] The Army uses Green Beret teams, long-range reconnaissance patrols, and Ranger units; the Marine Corps uses surveillance and target acquisition platoons and force reconnaissance teams; the Navy employs sea-air-land (SEAL) teams; and the Air Force uses aircrew debriefs as sources of human intelligence. Of the above, all are trained in intelligence gathering with the exception of the Air Force aircrews.[15] Of all the intelligence disciplines, HUMINT is the least integrated with the other sources.

Signals Intelligence

Signals intelligence is intelligence gathered from the interception and exploitation of electromagnetic transmissions. The three types of SIGINT are communications intelligence (COMINT), electronic intelligence (ELINT), and foreign instrumentation signals intelligence (FISINT).[16] All of the SIGINT disciplines are passive and can cue other systems.

COMINT is an excellent source of information on enemy order of battle, but even more important is its unique ability to gather enemy intent from the translations of literal communications. Some of the shortfalls of COMINT are its susceptibility to deception, the requirement for linguists, and the requirement to have line of sight with the transmitter for very high frequency (VHF) and ultra high frequency (UHF) systems. From an operational standpoint, one of the biggest drawbacks is that intelligence derived from COMINT is generally highly classified with limited distribution to protect sources.

ELINT is the interception of noncommunications emissions or radar. By comparing collected emissions to known equipment fits, ELINT provides tip-offs

as to the locations of command, control, and communications (C^3) nodes and air defenses. Again, as with COMINT, it is susceptible to deception and suffers from a line-of-sight requirement.

FISINT exploits information gathered from telemetry, beaconry, electronic interrogators, tracking/fusing/arming/firing command systems, and video data links. The advantages and problems of FISINT are similar to those of ELINT.[17]

Imagery Intelligence

Imagery intelligence is gathered from radar, photography, infrared, and electro-optical systems. Imagery intelligence provides enemy force location and movement information, early warning information, and terrain information.

Some limitations of imagery systems are that film and electro-optic systems are weather/haze dependent; radar systems are active, susceptible to countermeasures, and identify the reconnaissance platform; and tactical photography is not real time. Imagery has always been a labor- and resource-intensive process.[18]

Intelligence Collection Systems

The technical capabilities of each of the various collection platforms is classified beyond the scope of this monograph. Many of these collection systems are controlled and tasked at the national level. To assist commanders in understanding what these capabilities are and how to request their support, the Defense Intelligence Agency (DIA) has developed a Joint-Service Manual, *Joint Tactical Exploitation of National Systems (J-TENS),* that is a handbook on US reconnaissance programs and systems. It provides a quick reference on collection capabilities at the sensitive compartmented information level. This level of classification limits its availability to much of the tactical world. The DIA *Capabilities Handbook* (U) is a collateral supplement to the J-TENS manual and is published at the SECRET/NOFORN/WNINTEL level.[19] The following is an unclassified general overview of Air Force collection systems and is not intended to be all-encompassing.

RC-135—Signals Intelligence

The RC-135 is a reconnaissance version of the Boeing 707 that came into service in the 1960s. The RC-135 uses a main operating base/forward operating base concept to maintain a worldwide reconnaissance capability.

During peacetime, RC-135s support strategic national objectives, but during war or a contingency, the theater commander can task them in a tactical role. This role is becoming more important since RC-135s have participated in virtually every contingency in recent years. The Air Force has released few details as to the equipment or capabilities of the aircraft.

Senior Scout—Signals Intelligence

Senior Scout is a modular reconnaissance system that can fit on a tactical airlift aircraft with minimum modifications. Senior Scout is a modernized replacement for the Comfy Levi system.

Some of the key improvements include semiautomatic search receivers, graphic display terminals, tactical digital information link capability, a computerized data base, and voice/digital narrow-band and wideband satellite communications. The mission and capabilities are similar to the RC-135.[20]

RF-4—Imagery Intelligence, Electronic Intelligence

The RF-4 carries a variety of sensors including cameras capable of vertical, oblique, and panoramic photography, side-looking airborne radar, and infrared linescan equipment. Intelligence information from all of these systems must be processed after landing before the information is ready for use.

Some versions of the RF-4 have the tactical electronic reconnaissance (TEREC) system. This system collects ELINT and can data link selected signals to a TEREC receive terminal located on the ground.[21]

Advanced Tactical Reconnaissance System—Imagery Intelligence

The Air Force is currently developing an Advanced Tactical Air Reconnaissance System (ATARS) that will replace film-based cameras with electro-optic day- and low-light sensors and infrared linescanners that will record the information on digital tape and data link the information to intelligence centers. The data link will use a burst transmission technique for enhanced security and to reduce vulnerability to interference.[22]

Even though the Air Force will initially field the ATARS on the RF-4, this pod-mounted system will fit on any tactical fighter. This portability will extend the usefulness of this system after the Air Force phases out the RF-4 and eliminates dedicated tactical reconnaissance aircraft. A version for UAVs called the Unmanned Aerial Reconnaissance System is also under development. The medium range UAV can be air- or ground-launched and will carry the ATARS payload up to 350 nautical miles at high subsonic speeds.[23]

Joint Surveillance Target Attack Radar System—Radar Intelligence

Another of the newest surveillance systems under development is the Joint Surveillance Target Attack Radar System. As the name implies, J-STARS is a system that can maintain surveillance of the battlefield over an extended period of time. The mission of J-STARS compares to that of the E-3 airborne warning and control system—maintaining a constant radar watch—but J-STARS identifies and tracks slow-moving ground targets instead of airborne targets. J-STARS grew out of an Army heliborne Stand-Off Target Acquisition Systems Program and an Air Force program called Pave Mover that were designed to

provide rapid, continuous, broad area surveillance of moving ground targets. In 1982 the Office of the Secretary of Defense directed the formation of a joint program office to merge the two programs into the joint program.[24]

While various SIGINT collection platforms are available to detect and locate emitting targets, J-STARS principal targets are nonemitting targets, especially those in proximity to friendly forces. The deep surveillance capabilities of J-STARS, however, allow detection and tracking of mobile and stationary targets deep in enemy rear areas. This ability to watch enemy second echelon forces is essential to the successful prosecution of the "deep battle" of airland battle doctrine or the NATO follow-on forces attack.[25]

The two major elements of the system are the airborne multimode radar with associated displays and command, control, and communications equipment and the mobile ground station modules. The airborne radar has both wide-area surveillance and moving-target indicator modes that can cover an area of over 50,000 square kilometers, and a high-resolution synthetic aperture radar that produces a detailed photographic quality image to identify and locate fixed targets. Radar data is transmitted to the Army ground station modules located at the corps and division levels via the Surveillance Control Data Link (SCDL), while the Air Force plans to do its processing on board the aircraft and to send the information to USAF operational elements via the Joint Tactical Information Data Link and voice radio. The Air Force is considering using the SCDL to provide detailed surveillance information to intelligence facilities to be fused with other intelligence sources.[26]

The Army ground station modules are currently mounted in shelters on five-ton trucks but later will be mounted on Bradley fighting vehicles. An even smaller version will be put on the high mobility multipurpose wheeled vehicle.

Although not scheduled for initial operational capability until the mid-1990s, Gen Norman Schwarzkopf, then commander of the US Central Command, requested J-STARS for Desert Storm after seeing a demonstration in Europe. The military formed the 4411th Joint STARS Squadron with personnel from Air Force Systems Command, Tactical Air Command, the Army Communications-Electronics Command, and contractors (technicians came from Grumman, Motorola, Cubic Corporation, and Greenwich Air). Senior Army officers stressed that this baptism under fire "proved the value of airborne sensor data from the joint surveillance target attack system for command and control of combat forces." Ground commanders reportedly could see enemy activity up to 250 kilometers behind a 150-kilometer front.[27]

The Air Force was now in a position to target in near real time using information from the J-STARS. From the opening attack on Khafji to the massive retreat from Kuwait, J-STARS provided target information to Army and Air Force commanders. Isolated missile launchers, massive convoys going to and from the battle areas, enemy surface-to-air threats, and even blowing concertina wire were all detected and targeted based on J-STARS information. J-STARS even supported a search and rescue effort by confirming that no hostiles were in the area and that it was safe for search and rescue

forces to go in. Also unique to this intelligence platform was the real-time intelligence collection tasking from the various ground station modules. Army field commanders were able to communicate directly with the aircraft to request information or clarify reports.[28]

Joint STARS strengths are moving target coverage, multiple ground sites, direct support to the shooters, long on-station time, and wide-area coverage. Its weaknesses include aircraft survivability, limited number of platforms, limited resolution, and a single sensor susceptible to countermeasures.[29]

Advanced Synthetic Aperture Radar System-2—Imagery Intelligence

The Advanced Synthetic Aperture Radar System-2 (ASARS-2) on the TR-1 is the follow-on to the system on board the now retired SR-71. While J-STARS optimized looks for moving targets, the ASARS-2 is a side-looking, high-resolution radar that locates and monitors such fixed targets as command posts, communication sites, and lines of communication. It can also monitor vehicle concentrations and air defense sites. The ASARS-2 provides a high-resolution, photo-quality image using both broad-area search and spotlight modes. An operator on the ground controls the radar during flight and can focus on a particular target while watching the image in real time. (While the operator sees the situation in real time, the information takes about 15 minutes to reach the users.) The operator may also be able to get cueing information from SIGINT sensors on board the aircraft.[30]

The Army is developing mobile ground stations called tactical radar ASARS correlators that will provide radar target imagery directly to the field commander. A prototype of the system was deployed to the Persian Gulf during the early days of Desert Shield and provided continuous coverage as the Iraqis built their defenses in Kuwait and southern Iraq.[31] While the Air Force currently houses ground stations in hardened facilities in Europe and Korea, Air Combat Command is developing a contingency airborne reconnaissance system that will be deployable worldwide to support the air component commander.[32] NATO forces use a TR-1 ASARS-2 data manipulation system to receive, process, and disseminate ASARS information to NATO commanders in the Central Region.

The TR-1 mounted ASARS-2 provides wide-area coverage, long on-station time, good resolution, and multiple sensors for cross-cueing and resistance to countermeasures. It suffers from limited platforms, limited ground sites, poor aircraft survivability, and significant time delays to the shooters.[33]

Space Sensors—Measure and Signature Intelligence

The Defense Support Program (DSP) is the nation's satellite early warning system. It provides tactical warning of ballistic missile attack in near real time. The DSP consists of a series of satellites and their associated ground processing stations and communications network.[34] Space-based systems historically have supported national-level authorities, and support to tactical forces has

trickled down. To correct this, each of the services has established a Tactical Exploitation of National Capabilities Program (TENCAP) to speed up and expand the intelligence gathered by satellite systems. But, as recently as Desert Storm, "operational planning for the use of space systems was not well developed" according to Lt Gen Thomas S. Moorman, Jr., commander of the Air Force Space Command.[35]

One notable exception was the missile warning reports that went out to Patriot batteries in the Persian Gulf that allowed them to intercept incoming Scud missiles.[36] As previously stated, satellite surveillance systems were designed for the strategic threat, but as Gen Donald J. Kutyna, commander in chief, US Space Command, told the Senate Armed Services Committee:

> Today, we are laying the foundation for improved tactical warning/attack assessment and future space operations supported by upgrading our ground- and space-based surveillance assets and our systems in Cheyenne Mountain. DoD has recently adopted a new strategy to acquire a follow-on program to the Defense Support Program which will correct the system's most significant deficiencies.[37]

He went on to emphasize the requirement to provide reliable and unambiguous warning against the ever-increasing threat from third-world tactical ballistic missile systems. The unified and specified commands have expressed strong support for a space-based surveillance system that "must provide continuous, near-real-time, all-weather, day-night coverage directly to combat forces."[38] General Kutyna sees tactical satellites "based on an inventory of ready to launch boosters and satellite mission packages tailored to the needs of our warfighting commanders" as one way of providing this support.[39] These satellites would not replace existing systems, but would augment existing capabilities during contingencies.

Unmanned Aerial Vehicles—Imagery Intelligence, Signals Intelligence

Drones, remotely piloted vehicles, or unmanned aerial vehicles have had an up-and-down history in the Air Force. Many leaders have endorsed the concept from time to time, but systems that suffered from immature technology have led to disappointing results.

UAVs are now becoming popular again to perform the "dull, dirty, and dangerous" missions. Because of their endurance and lack of an aircrew, they are ideal candidates for reconnaissance and surveillance missions. They can fly over hostile targets before and after attack to provide surveillance, target acquisition, and battle damage assessment. UAVs offer a reduced radar cross section, a lower infrared signature, and lower noise levels than their manned counterparts. The Army and Marine Corps are developing a short-range system. The Air Force and Navy are building a medium-range system that will carry the ATARS and an endurance UAV to fly at over 60,000 feet, stay airborne for 24 hours, and have applications similar to a low-earth-orbit satellite.

UAVs have had considerable success in recent years. The Israelis used them in the Yom Kippur War and the 1982 Peace for Galilee Operation in the Bekaa Valley. The Navy used UAVs on the USS *Wisconsin* to spot for the battleship's 16-inch guns during Desert Storm. The commander of the Sixth Fleet stated that "the remotely piloted vehicle has proven its capability and has added a new dimension to real time intelligence."[40] Marines used UAVs to map Iraqi minefields and bunkers in planning their advance to Kuwait City, and they used UAVs to locate and direct counterbattery fire on Iraqi artillery. The Army used UAVs to provide "targeting information to attack aviation assets and for the ground launched Army Tactical Missile System (ATACMS) used against Iraqi positions."[41] Lt Gen Charles A. Horner, the Central Air Forces commander, said the

> *impact of UAVs was intensified because of the lack of other good battlefield intelligence* [emphasis added]. They were valuable for spotting the Iraqis massing for attack and helping the allies anticipate where air support would be needed.[42]

UAVs are capable of carrying several SIGINT or IMINT packages. As the Air Force reduces its manpower and the dedicated manned reconnaissance systems are retired, UAVs are destined to pick up a greater role in future Air Force reconnaissance/surveillance missions.

Intelligence Processing and Dissemination Systems

As the volume of information collected has grown exponentially, so has the requirement to put it together in a format that is useful to the consumer and that can be transmitted in a timely manner. According to Brig Gen William E. Harmon, USA, the program manager for the Joint Tactical Fusion Program:

> The most sophisticated intelligence collector in the world is worthless if the information it provides does not reach the commander in a timely manner. . . . The US has very efficient battlefield intelligence collection systems today, but management of those collection assets and the processing of their information are extremely inefficient.[43]

Joint Service Imagery Processing System (Processing)

A historical problem in the development of collection systems (reconnaissance and surveillance) has been "stovepipe" system architectures. Each particular collector has its own processing and reporting system. The Joint Service Imagery Processing System (JSIPS) being developed in conjunction with the ATARS system is an attempt to help correct this problem. JSIPS is the common mobile ground station for processing, exploiting, and disseminating time-sensitive imagery information to field commanders in near real time (for the JSIPS program near real time is defined as within 15 minutes of data receipt). JSIPS will be capable of processing digital imagery from a variety of imagery producers. In addition to film, it will be able to process digital electro-

optical, infrared, and radar imagery. JSIPS will be capable of exploiting imagery in both soft copy (on screen) and hard copy (film) formats.

Air Force Systems Command has plans to develop an imagery reformatter system to expand the JSIPS capability to handle infrared, electro-optic, advanced synthetic aperture radar-2 and synthetic aperture radar imagery from other platforms as well.[44] The front end of the JSIPS system includes two modules that contain the antennas and receivers to receive imagery from either tactical (ATARS) or national systems.

The Air Force has decided to acquire one national-level receiver and four or five tactical receiver sets.[45] Due to this limited number of systems, they will most likely be located only at the tactical air control center or Air Force fusion center. Timeliness is the biggest selling point of the JSIPS program, as pointed out by Bruce Gumbel and Glenn Goodman in the *Armed Forces Journal International.*

> JSIPS is expected to reduce the time required to process reconnaissance imagery from two to three hours to minutes by largely replacing manual photo processing and interpretation with computerized analysis of digital video imagery downlinked directly from the reconnaissance aircraft.[46]

JSIPS ground stations will provide target photos based on ATARS video imagery to wing operations centers for aircrew study before air strikes.[47] The heart of the system is a workstation that provides variable playback speeds, real-time translation, rotation and magnification, target location, map overlay, and image data insert.[48]

The JSIPS will be linked to the outside through a series of communications gateways. It will have STU-III and KY-68 capability for voice, automatic digital network and defense digital network capability for message traffic. It will comply with the national imagery transmission format to ensure compatibility with such secondary imagery transmission systems as the interface processor for imagery exchange, the tactical digital facsimile (TDF), and the fleet imagery support transmission. Additionally, JSIPS will provide an output in hard copy or on magnetic media.[49]

Other major advantages of the JSIPS are reduced airlift requirements and decreased signature presented by the smaller configuration. The three to six required computer-equipped mobile shelters are in stark contrast to the 28 shelters of today's reconnaissance squadron.[50]

The ATARS/JSIPS combination provides high-resolution imagery, penetration capability, tactical flexibility, and commonality with several platforms. Its weaknesses are limited coverage and significant time delays to the shooter.[51]

Enemy Situation Correlation Element (Fusion)

No matter how effective or timely an intelligence collector is, it must be fused with other intelligence sources and disseminated to the consumer, whether the user be the decision maker at the Army/Air Force headquarters or a shooter in a tank, air defense battery, or cockpit. Current sensors "vacuum the

environment" and often provide so much information that they overload the communications system.

To better coordinate the efficient use of surveillance/reconnaissance systems and selection of second-echelon targets for the AirLand Battle, the Army and Air Force are developing automated intelligence fusion centers under the Joint Tactical Fusion Program. The Army All-Source Analysis System (ASAS) and the Air Force Enemy Situation Correlation Element (ENSCE) speed the fusion and correlation of intelligence sources and provide a common view of the battlefield. Just as important, the ASAS/ENSCE will determine what we do not know and will allow retasking of sensors to gather that specific information. When that priority information is reported, it will be highlighted for the analyst. The ASAS/ENSCE system will be an all-source system, receiving inputs from tactical Army collection systems (such as Guardrail and Quicklook), J-STARS, ATARS, and national intelligence sensors. Intelligence data will be overlaid on a situation display providing an all-source picture of enemy locations and direction of movement, allowing commanders to project routes of advance and plan interdiction strikes.[52] ASAS/ENSCE terminals will be located at the corps and division tactical operation centers and the Air Force tactical air control center.[53]

The Battlefield Information Collection and Exploitation System is a similar effort under way within NATO to fuse and correlate intelligence, not only from a wide variety of intelligence disciplines and collection systems but from different countries. This ambitious effort is aimed at integrating national and multinational fused intelligence systems into a common architecture suitable for use theaterwide.[54] There is still a great deal of work to do to fully integrate these systems.

Sentinel Byte (Processing and Analysis)

The systems just discussed only provide intelligence to the headquarters level. To get this all-source intelligence to the operational consumer at the wing and squadron level, the Air Force is deploying the Sentinel Byte system. The Sentinel Byte program is the Air Force's effort to field a unit-level intelligence system for Air Force conventional operations and provide automated support for intelligence input into the mission planning and intelligence operational functions. This program is providing the hardware and software for the lower echelons to interface with theater and national intelligence data bases.

Sentinel Byte is an interactive intelligence system for passing intelligence, targeting, and battle damage assessment information up and down the chain of command within the tactical air control system. The ultimate goal of Sentinel Byte is to provide "the means to concentrate, collate, and manipulate data; to receive and generate reports and instructions; and to operate in a multisource and multilevel security environment."[55] It currently receives inputs of order-of-battle updates and secondary imagery and manual inputs on the threat and targets. It is also capable of receiving near-real-time broadcasts of threat

activity. It supports intelligence briefing preparation, mission planning, and target materials support by providing hard-copy/soft-copy slides, wall map overlays, reference data, threat locations, and near-real-time threat displays to battle staffs, mission planners, and aircrews. During Desert Storm, the Sentinel Byte terminals received order of battle updates twice daily over tri-service tactical communications dial-up telephone circuits. Improving this timeliness and adding inputs from JSIPS are improvements scheduled for December 1994.

Maj Gen Schuyler Bissell, while serving as the assistant chief of staff for intelligence, stated that as technology advances "our doctrine, organizational structures, and procedures must be capable of exploiting the full potential of advanced technologies" and that intelligence systems had "the potential for interfacing directly with the man in the cockpit."[56] The Air Warfare Center is exploring this capability through a Real Time Intelligence in the Cockpit Program that is investigating intelligence requirements, dissemination systems, and display formats.

Constant Source (Processing)

Constant Source is a broadcast system designed to provide timely intelligence to combat units and elements of the tactical air control system at the secret or higher level. Constant Source integrates and correlates information received from the tactical receive equipment and related applications (TRAP) broadcast, the tactical digital exchange system-B, and the Tactical Information Broadcast Service. It displays that information on a single, small tactical equipment set composed of the Constant Source receiver suite (CSRS) and the Constant Source operator's terminal (CSOT).

The Constant Source correlator eliminates redundant reports, compares new information against a known order of battle and updates data bases, refines emitter locations, and identifies moving targets and movement of known sites.

To prevent being overloaded by information, the CSRS filters incoming information by area of interest, signal of interest, time of collection, and geolocation accuracy. The CSOT provides a color graphic display of correlated tracks overlayed on a map. The operator is alerted to events of high interest and can watch events in near real time or review past events for trend analysis. The CSOT provides intelligence for indications and warning, mission planning, threat avoidance, and over-the-horizon targeting. It also can be integrated into other automated networks and mission applications (e.g., Sentinel Byte and the Mission Support System).

Air Force Space Command is sponsoring a program to miniaturize the required equipment into the Multi-mission Advanced Tactical Terminal (MATT), which would provide the same capability to the aircraft cockpit or mobile ground users. At approximately one-tenth the size of a Constant Source system and weighing less than 50 pounds, the MATT will provide an unprecedented mobile capability.[57]

Secondary Imagery Transmission Systems (Dissemination)

Once an image has been taken and processed, it must be passed to the consumer physically or over a secondary transmission system. There are a multitude of secondary imagery transmission systems within the Department of Defense. A typical one in the Air Force is the Intra-theater Imagery Transmission System (IITS). IITS provides secure imagery transmission and communications support to the tactical commander. IITS is comprised of the interface processor for imagery exchange, which is the front-end processor for the imagery and the TDF.

The TDF is a facsimile machine similar in capability and operation to commercial facsimile machines, but built to withstand the rugged environment encountered in military operations. Much maligned in the press prior to Desert Storm for their cost, TDFs proved their worth as they were initially the only secure communications available to many units in the Gulf, and they held up under the brutal environmental conditions while commercial facsimile systems melted in the desert heat. Security was provided via an assortment of encryption devices and STU-III secure telephones.[58] Problems with the TDF system were that it was a point-to-point system, transmission was time intensive, and imagery quality was not always suitable. The high volume of data also consumed much of the available communications capability.[59]

Another imagery transmission technology is slow scan TV. This is essentially a standard television system that does not have full-motion capability. By reducing the requirement for instantaneous updates to the image, the bandwidth required for transmission is reduced to three kilohertz from five to six megahertz. This technology is ideally suited for the transmission of briefing maps and weather information, and it has teleconferencing capabilities for C^3 applications as well.[60]

A third technology for the distribution of secondary imagery is computer-to-computer transmission for soft copy exploitation by analysts at their workstations. Electronic transmission and display of imagery allows the analyst to use computer enhancement to sharpen the image and glean more details from the picture.

As the size and cost of imagery systems shrink and the technology advances, it may be feasible in the near future to have a series of unmanned observation posts that broadcast real-time imagery to units located back from the front line. These observation posts would allow continuous surveillance of key areas without putting personnel at risk.

Joint Tactical Information Distribution System (Dissemination)

The Joint Tactical Information Distribution System (JTIDS) will provide digital communication for command and control, navigation, relative positioning, and identification. The class 2 JTIDS terminals are compact systems designed for fighter aircraft, ground tactical vehicles, and other installations

having space and weight restrictions. Designed to provide a "God's eye view" of the battlefield, JTIDS hopes to provide tactical elements in the air and on the ground positional information on themselves, their supporting forces, and the enemy. For example, using the F-15 JTIDS armament display unit, pilots will be able to select routes, waypoints, and targets; recovery and emergency air bases; locations of friendly, hostile, and unknown aircraft; locations of friendly and enemy ground forces; and the latest reported position of the forward edge of the battle area. The information displayed will be a combination of information derived from onboard and off-board sensors. Pilots will be able to interrogate enemy aircraft symbols, and if the information is available, a display will show altitude, track, and speed.

JTIDS has a range of 300 nautical miles in line of sight with an extended-range option of 500 miles. It uses time-sharing of randomly hopped frequencies to service multiple subscribers to the network. This rapid hopping over several hundred megahertz on a pulse-to-pulse basis, along with spread spectrum transmission techniques, provides significant resistance to jamming in that a jammer would require enormous amounts of power. Additional protection against jamming or unintentional interference is provided through the use of a forward error correction code. This code permits recognition of the information in messages where up to 50 percent of the information cannot be read.[61]

Summary

The trend in reconnaissance/surveillance systems is toward increased timeliness, increased all-weather coverage, and increased survivability in the face of technologically advanced threats—all while attempting to live within ever-tightening fiscal restraints. To achieve these results, there are plans to improve the electronics of the systems including the sensors, data links, and soft copy exploitation systems. Improved communications systems include the Defense Digital Network, the Military Satellite Communications System, and improved laser and fiber-optic communications.

Additionally, extensive research is being conducted on the uses of artificial intelligence for automatic pattern recognition and other techniques to reduce the analyst's work load and time line. The use of stealth technology and unmanned aerial vehicles to increase survivability and highly compact mobile ground systems to improve support to the tactical commander are all under development or investigation.[62]

The intelligence community is continually striving to increase the timeliness and accuracy of the intelligence product provided to the consumer. The speed and accuracy of today's systems are dramatically better than their predecessors, but the tempo of operations has still outpaced the ability of intelligence to keep up. This is not a new phenomenon but a continuation of a historical complaint.

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Chapter 3

The Historical Perspective

As we search for that correct balance we can neither adopt the unrealistic assumption that *nothing* has changed nor the historically naive position that *everything* has changed [emphasis in original].

—*The Air Force and U.S. National Security: Global Reach—Global Power*

This chapter is not a comprehensive history of reconnaissance. Instead it shows the trends in military aerial reconnaissance from its birth in the late 1700s to its performance and use in Desert Storm.

Throughout history, commanders have wanted more intelligence and wanted it faster, but reconnaissance is an area easily neglected during peacetime and periods of austere budgets. Thus feasible capabilities are often not available at the start of hostilities.

Pre–Civil War

Since the early days of warfare, man has wanted to see over the next hill, and one of the long-recognized advantages to holding the high ground is to better see your enemy's movements. Today the "high ground" is held by aircraft and spaceborne reconnaissance and surveillance systems.

America's envoy to France in 1783, Benjamin Franklin, noted one of the early experiments with balloons and wrote that balloons could have a military use "such as elevating an engineer to take a view of an enemy's army, works, etc."[1] The first recorded use of aerial reconnaissance was by the French against the Austrians in the Battle of Fleurus in 1794. The French used an observer in a tethered balloon to spy on the positions of the Austrian forces.[2] The observer relayed information on enemy positions and troop movements to the ground via signal flags and by putting messages in a sandbag and sliding the bag down the tether lines on metal rings. The advent of the antiaircraft gun followed as the Austrians lowered the tailpieces of cannon into trenches to raise their maximum elevation. Austrian gunners sent one shot over the observer's head and another grazed the gondola forcing the aerostiers to increase their altitude.[3] The first aerial photograph is also credited to a Frenchman, Felix Nadar. In the spring of 1856, he took photographs of Paris from a balloon.[4]

Civil War

The United States' first ventures into aerial reconnaissance took place during the Civil War when Maj Gen Benjamin F. Butler hired T.S.C. Lowe, a freelance aerial observer, who acquired the impressive title of chief aeronaut of the Army of the Potomac.[5] Lowe went up at night in a tethered balloon and counted the tent lights of the hidden Confederate forces.[6] Later, observers ascended during daylight and used a telegraph to pass information down to commanders. This practice may be the first near-real-time intelligence support provided by aerospace forces.

A regular Union observer during the war was Lt George Armstrong Custer. There is no documented sample of aerial photography during the Civil War, but the suggestions of a Capt Albert Tracy, an infantry officer, written to General Butler closely resembled the method by which aerial mosaics were made in the 1940s.[7]

The Confederates had a limited balloon effort, but were plagued with accidents and technical problems. Tethered and free-flight balloon reconnaissance missions continued throughout the Civil War with mixed results.[8]

Through World War I

The Aeronautical Division of the Signal Corps of the US Army was established on 1 August 1907 to be responsible for all matters concerning military aviation, both balloons and aircraft.[9] In November 1910, William P. Mayfield shot the first photograph taken from an aircraft. The photograph was of an aircraft hanger in Dayton, Ohio. The pilot of the aircraft was none other than Orville Wright.[10]

Tactical reconnaissance is air power's oldest mission, but these years only the most zealous aviation advocates saw much, if any, military utility for airplanes because of their extremely limited flight performance. At most, the Army viewed the airplane as a kind of aerial cavalry scout, and Army field service regulations of 1914 stated "the aero squadron will operate in advance of the independent cavalry in order to locate the enemy and to keep track of his movements."[11] In the spring of 1916, the Army assigned the 1st Aero Squadron under the command of Maj B. D. Foulois to Brig Gen John J. ("Blackjack") Pershing to assist in pursuing the Mexican bandit Pancho Villa. Poor airplane maintenance, accidents, and bad weather prevented the squadron from making a significant contribution and seriously depleted the number of available aircraft. A year later the pitifully small air force that had been unsuccessful in its attempts to pursue a Mexican bandit embarked on the tremendous production and training program called for by the United States' entrance into World War I.[12] At the start of US involvement in that conflict, Jose Caruo, a Spanish military expert ranked the air forces of the world as follows:

France, Germany, Italy, Russia, Britain, Belgium, Sweden, Rumania, Greece, Spain, Argentina, Bulgaria, China, Mexico, [and] Turkey, and [he observed] that the United States did not appear to have an air arm as such.[13]

During World War I, the airplane got its first taste of combat. Both sides entered the war with about 180 airplanes. Britain and France had 13 dirigibles versus the 12 Zeppelins of the German army. When the US entered the war in 1917, the armies of both sides were stalemated in trench warfare. General Pershing felt that "the air service became the main source of information regarding the enemy's trenches, his movements, and his positions."[14] According to Gen William ("Billy") Mitchell, "German and Allied reconnaissance operations were so successful . . . that the close of 1917 marked the end of all major troop movements in the European theater during the day."[15] The use of aerial reconnaissance by both sides prevented either from building up reserves or munitions without being countered and ultimately contributed to dragging out the war.[16] The Army Division of Military Aeronautics recognized the advantages of a surveillance platform (balloon) versus a reconnaissance platform (airplane) as described in the *Principles Underlying the Use of Balloons:*

> When a mission can be performed by both an avion and a balloon, it should be assigned to the balloon, because the balloon can fulfill it's mission more quickly . . . [it has the advantage] of the permanence of observation [making] it possible to follow changes on the battlefield.[17]

There is anecdotal evidence that a private soldier took the first military aerial photographs on a flight over the front during a World War I battle. When his superiors found his illegal camera, they confiscated it and developed the film, which provided accurate and detailed information that the observer in the aircraft had overlooked.[18]

The complete lack of aircraft radios early in the war and their limited availability towards the end prevented aerial reconnaissance support of ongoing operations and confined support to ground and air mission planning.[19]

Through World War II

While aircraft were used sporadically during the Mexican campaign of 1916 and World War I, tactical air reconnaissance came into its own during the Second World War. As late as 1939, the US Air Corps had observation balloons as part of its organizational structure,[20] and each of the nine US Army corps had their own observation squadron consisting of six or more outdated low-performance aircraft.[21] Each corps commander used his aviation arm as he saw fit, and there was no centralized control or standardization of aircraft or procedures.

Between the wars, the development of reconnaissance capabilities took a back seat to the development of bombardment capabilities, and while the military recognized the need for an improved reconnaissance capability, it took "the actuality of war before the development of these items would be

expedited."[22] Gen Henry H. ("Hap") Arnold's statement that 7 December 1941 "found the Army equipped with plans but not with planes" was an accurate assessment of the United States' reconnaissance capabilities at the outbreak of World War II.[23] With this inefficient organizational framework, obsolete aircraft, and doctrine and concepts left over from World War I, the US entered the war.

At first, due partially to our late entry into the war, US forces had to rely heavily on the British for aerial intelligence. In addition, "the AAF [Army Air Forces] probably was more deficient in its provision for intelligence than in any other phase of its activities."[24] The mechanization of warfare, both on the ground and in the air, meant that to understand the intent of the enemy in time to do something about it, it was necessary to conduct reconnaissance well behind the enemy lines. The US practice of giving each ground commander his own reconnaissance aircraft led to shortsighted and inefficient use of assets. British reconnaissance was centrally controlled as was the rest of their air forces. The Royal Air Force (RAF) would later become the model for the organization of our Air Force.

Based on the 1943 War Department ruling that the "AAF was responsible for providing reconnaissance and must devise the means to execute the mission," General Arnold initiated a program to convert high-performance fighters to the reconnaissance role.[25]

Most aerial reconnaissance in World War II was visual with limited photo capability. Only one unit in the European theater had a night photo capability.[26] Modified B-17 Flying Fortresses and B-24 Liberators provided some photographic reconnaissance, but these aircraft were extremely vulnerable to enemy fighter attack unless they were heavily escorted as part of a large bomber formation or were escorted individually with what scarce fighter escort was available. Gen George S. Patton, Jr., used modified P-38s as his eyes on the battlefield and, after breaking out from the Normandy beachhead, used tactical air power to watch and protect his otherwise unguarded right flank.[27] Throughout World War II, tactical air reconnaissance provided from 50 to 90 percent of the combat intelligence available in Europe.[28]

While unarmed or lightly armed fighters accomplished the majority of reconnaissance in the European theater, due to the great distances in the Pacific, some reconnaissance aircraft were armed to attack perishable tactical targets. B-17s and B-29s were the mainstay of the reconnaissance force in the Pacific because of their greater range and ability to defend themselves against Japanese fighters.[29]

The Army Air Force Reconnaissance Sub-board of 1943, learning from the British experiences in North Africa, made a distinction between strategic and tactical reconnaissance. The British viewed air power at the operational level of war while the Americans viewed air power from the tactical level of war.[30] Strategic reconnaissance was theaterwide and emphasized the enemy infrastructure. Tactical reconnaissance emphasized support to the ground commander. The board's effort was one of the first attempts to look at reconnaissance from a theaterwide point of view and was the first time that anyone had acknowledged

that the air commander had a requirement for information strictly for his own use beyond the purview of the ground commander.[31]

The board's work was also a precursor to FM 100-20, *Command and Employment of Air Power,* which established that "land power and air power are co-equal and independent forces; neither is an auxiliary of the other."[32] Many Army ground commanders expressed concern about this document and felt that the interests of the air forces would take priority over those of the ground forces, particularly the infantry.[33] FM 100-20 introduced the principle of flexibility and centralized command and control of air forces. AAF units would not be attached to ground units except for special circumstances, such as independent operations and cases where units were isolated by distance or lack of communications.[34]

With the centralization of air reconnaissance came the requirement for a method to rank the importance of reconnaissance requests. Each army group, army, and corps headquarters established an air branch within the G-2 (intelligence) section. The army group G-2 air was the focal point for collection management: collecting requests, ranking them, submitting the requests to the tactical air forces, and disseminating the finished product. Ground liaison officers at the tactical air forces debriefed returning aircrews and forwarded their reports to the G-2 air by radio or telephone.[35]

Despite entering the war woefully unprepared, tactical air reconnaissance made tremendous contributions to the war effort and received high praise from ground and air commanders alike. Some lower echelon commanders were dissatisfied with the timeliness of the system and advocated assigning reconnaissance squadrons to the corps. Gen Leslie J. McNair attributed this discontent to "the invariable tendency on the part of unit commanders to make themselves self-sufficient." The communications and intelligence dissemination systems contributed to a great deal of the discontent. The General Board of 1945 substantiated this problem with these systems when it reviewed reconnaissance effectiveness in Europe.[36]

Up to this point, aviation intelligence had been synonymous with observation and aerial photography, but two other intelligence sources grew to significance in WWII and were crucial to the air war in specific and the whole war effort in general.

The first of these was the British development of radar. During the Battle of Britain, from July 10 to 31 October 1940, 47 Chain Home stations (as radar stations were then known) guarded the approaches from the English Channel and North Sea. They provided the badly outnumbered RAF advance warning as to the size, direction, and timing of Luftwaffe raids on England. From his underground headquarters west of London, Air Chief Marshal Sir Hugh Dowding received reports from each radar station, plotted the course for each inbound raid, and the course for the intercepting RAF flight. In August 1940, Dowding had only 666 RAF fighters facing German Air Marshal Hermann Goering's almost 2,400 long-range bombers, dive bombers, fighters, and reconnaissance aircraft. With sufficient foreknowledge of the enemy's strength,

Dowding was able to husband his forces, inflict a two-to-one loss ratio on the Germans, and ultimately force Hitler to postpone the invasion of England.

In the Pacific, the US Navy effectively used radar in the latter stages of the war to warn their fleets of enemy carrier- and land-based raids as our carrier groups struck the Japanese homeland in preparation for the invasion that was never to come.[37]

The other intelligence source that played a crucial role in strategic planning was signals intelligence. Cryptologists had broken the "unbreakable" German machine cyphers and had provided Allied senior leaders information on German strategic planning. Few people were told the source, and not many more were given the results of the exploited intelligence for fear that the Germans would discover that the Allies had broken their codes; and this vital source would be lost.

During the Battle of Britain, SIGINT information provided the British with virtually an exact order of battle for the Luftwaffe including airfields to be used, unit designations, unit strengths, and loss rates as reported to higher headquarters. As Goering and other senior staff officers toured their commands, SIGINT collectors followed their progress and expanded their knowledge of German capabilities. By August of 1940, crytographers were intercepting and decoding up to 300 messages a day from the German high command noting time over target, targets, numbers of escorts, and other intelligence of incredible value to the badly outnumbered British. Besides warning of impending raids, SIGINT intercepts indicated loss of morale, supply and repair problems, and Goering's increasing frustration with his inability to crush the RAF.[38]

In the Pacific, radio intercept units on board US Navy ships collected tactical aircraft communications. These communications provided critical information that allowed the interception and destruction of many Japanese aircraft.[39]

Through the Korean War

With the establishment of a separate US Air Force in 1947, tactical air reconnaissance became more centralized and further removed from the supported ground commander. Additionally, budgetary limitations in 1948 resulted in disbanding all tactical reconnaissance in the United States except for one day and one night squadron. The result was that reconnaissance capabilities at the start of the Korean War were in worse shape than at the start of World War II.[40] Robert F. Futrell, a noted air power historian, stated that "of the four aspects of air activity, reconnaissance was the slowest to meet the needs of the war emergency,"[41] and the commander of the Far East

Air Forces reflected that "the quality of tactical reconnaissance is just about comparable with that which went on in World War II."[42]

At the outset of the war, there was no established procedure to handle reconnaissance requests. Requests were literally called in from all over the theater which made an organized collection effort impossible.[43] Eventually all tactical reconnaissance assets were controlled though a joint operations center. A large percentage of the targets were Air Force requests, and soon complaints arose that the Eighth Army had "not been able to obtain adequate intelligence from aerial sources since the start of the war."[44] Not only did the Army suffer from a lack of priority, but there was such a serious shortage of trained imagery interpreters that the 67th Tactical Reconnaissance Wing could not take advantage of the full photographic capabilities of the systems available. In fact, the wing only gleaned 20 percent of the information available in the photographs the interpreters did exploit.

During the Korean War, the tempo of warfare accelerated, but the intelligence system did not keep pace. While new aircraft such as the RF-80 and RB-45 were in use, the basic sensors were of WWII vintage. This lack of a long-range, all weather, day-night capability directly led to the failure to detect the massive Chinese buildup along the border. Using the cover of night and effective camouflage techniques, the Chinese achieved total surprise against United Nations' forces in late 1950.[45] Making use of similar techniques, the North Koreans and Chinese made most of their movements and resupply efforts at night. During the Chinese push south in November of 1950, friendly forces could not locate the communist forces despite having taken 27,000 photographs in a 10-day period.[46] At the close of the war, Gen O. P. Weyland, Commander of Far East Air Forces during the war, stated that

> had adequate surveillance been available to them, the early losses of troops and ground would have been greatly reduced. . . . Aerial surveillance was not adequately available and in some cases United Nations forces retreated when there was no need, and at other times held, to be ambushed on retreat.[47]

He further reflected that old lessons had to be relearned as they had been forgotten, never documented, or if documented, never disseminated.

The USAF Security Service provided signals intelligence support during the Korean War, but security concerns initially resulted in all signals intelligence being filtered in the US before being provided to in-theater forces. This prevented the tactical commander from receiving anything of tactical use. In 1952, a directive from the Fifth Air Force commander, Gen Earle Partridge, initiated the providing of SIGINT support to ground controlled intercept (GCI) operations. Security Service personnel on Cho-Do Island started providing intelligence support to (GCI) controllers, also located on Cho-Do Island. This intelligence increased the controllers' effectiveness and contributed to more than 150 MiG kills during the last six months of the war.[48]

Through the Vietnam War

The rapid demobilization following the Korean War and the defense strategy of "massive retaliation" during the Eisenhower administration once again left the US tactical reconnaissance capability crippled. The Cuban missile crisis and the growing insurgency in Vietnam found the US with only one tactical reconnaissance wing. President John F. Kennedy called for new strategies and tactics, new weapons, and new ideas to counter the Soviet strategy of using satellite states to carry out Soviet policy. The Kennedy strategy of flexible response required an increased reconnaissance capability, and the Air Force activated two new wings by 1966 in response to this strategy and the growing war in Southeast Asia.[49]

The capabilities of reconnaissance sensors still had not improved much by the start of the Vietnam War. Later the introduction of the RF-4 and the Army OV-1 Mohawk with dramatically improved sensors gave the first true night/all-weather capability using a side-looking airborne radar.[50] RB-57s introduced infrared reconnaissance with its ability to locate the enemy through detection of enemy campfires. Intelligence analysts had to process the information after landing. Artillery fire based on the RB-57 reconnaissance could be delivered within two to six hours.[51]

The introduction of the Mohawk was significant as well for heralding the Army's efforts to regain control of tactical reconnaissance assets to support the ground commander. Each field force had an aviation company equipped with OV-1 aircraft. The size of the unit depended on the terrain features in the area of operations.

In Vietnam, high-altitude photography proved to be useful only in identifying static installations and lines of communications. Gen William W. Momyer, commander of Seventh Air Force from 1966–1968, reflected that

> although SR-71s and other reconnaissance platforms provided considerable information, their information was not timely or pertinent to targets planned for a particular day. Most of the information produced by these platforms was used by national intelligence agencies for detailed evaluation of the effects of air attacks on the military, political, and economic life of the country. [I]nformation [from national agencies] was slow in reaching the field and had little influence on the hourly decisions of how to best strike the targets.[52]

Tactical imagery support to counterguerrilla operations was virtually nonexistent. Based on a one-month study in 1968, it took from three to 51 hours from time over target to produce selected target photos. The average time to deliver these photos to tactical units was between 30 and 56 hours. Even the immediate photo interpretation report (IPIR), which provided the initial written report of significant intelligence information, took an average of 29 hours to reach the tactical consumer.[53] It was common to plan air strikes against tactical targets using five-day-old film.[54] Imagery used for target development or in support of operational planning took 10 days from the initial request to actual delivery of the product to the requestor.[55] Approximately

one-half of the time delay for target photos was due to courier pickup and delivery delays. Three-quarters of the time delay for IPIRs was attributed to communication system problems.[56] Another source of delay was the sheer volume of imagery processed. By 1968, 3 million feet of imagery per month was being produced, much of it obsolete or unwanted by the time it reached the requestor.[57] The Army Military Intelligence Battalion Aerial Reconnaissance Support was responsible for the ultimate delivery of Air Force imagery products to Army end users and did not always have the necessary aircraft or sense of urgency. Dissatisfied Army consumers often did not realize that the Army frequently caused the delay and placed the entire blame on the Air Force.[58]

Since it possessed only reconnaissance systems and no effective battlefield surveillance systems, the Air Force had to fly multiple passes against many targets to keep a current status. When the Air Force initiated an interdiction campaign in Laos in 1968, it photographed selected targets, such as mountain passes, several times a day to ensure that they stayed closed.[59]

One attempt at a ground surveillance system used air-implaced Igloo White acoustic ground sensors. These enemy-activated sensors "heard" activity and transmitted the information to an orbiting EC-121R which automatically relayed the information to an infiltration surveillance center at Nakhon Phanom Air Base, Thailand. While primarily used along known infiltration routes, Igloo White sensors also provided valuable information during the siege of Khe Sanh by pinpointing enemy troop concentrations for artillery fire and air strikes.[60]

The highest levels within the Air Force recognized the requirement for faster intelligence support to the ground commander. In 1968, Lt Gen Glen W. Martin, the USAF deputy chief of staff for operations stated that

> wars fought largely by the thrust of hit and run tactics as opposed to massive confrontation have imposed a difficult requirement for more accurate and more timely information about the enemy, his strengths, weaknesses, and movements. The intelligence needs of a more mobile and faster reacting ground force do not allow the luxury of days—or even hours—in performing the reconnaissance role.[61]

Commander in Chief, Pacific Air Forces, Gen John D. Ryan in a 1968 message to the commander, Seventh Air Force, commented that Army and Marine requests for Air Force reconnaissance had been declining for months because of slow Air Force response times. Among the causes identified for these problems were (1) the low priority given to in-country reconnaissance by Seventh Air Force, (2) a lack of sufficient imagery processing and exploitation resources in Southeast Asia, (3) Seventh Air Force failure to apply current doctrine and concepts, and (4) the Army desire to maintain a large organic intelligence capability.[62] In early 1969, the Seventh Air Force deputy chief of staff/operations stated that the Air Force's inability to provide real-time intelligence on small fleeting targets to the Army led the Army to use OV-1 Mohawks under its control. The Army relegated the Air Force to providing intelligence on more stationary targets.[63] Even the Military Assistance Command, Vietnam (MACV) directive on reconnaissance requests emphasized that while

requests could be initiated at any level, "missions will be accomplished at the lowest possible echelon *utilizing organic, assigned, or direct support aircraft.* Missions which cannot be accomplished at lower echelons will be submitted to J-2 Air" [emphasis added].[64]

Compartmentalization of intelligence was another significant problem. The intelligence community viewed compartmentalization as safeguarding sources and methods of intelligence, but operations personnel suspected that intelligence was keeping the "good stuff" behind the "green door." Often there was considerable compartmenting of information within the intelligence community with analysts cleared for SR-71 photography uncleared for communications intelligence. Intelligence officers cleared for all types of intelligence tended to be headquarters personnel who briefed the generals—not wing- or squadron-level personnel supporting the aircrews.[65]

While recognizing the problem, the Air Force did not come up with an adequate solution. One attempt to overcome the inadequacies of the near-real-time reconnaissance system was the Tactical Activity Display System (TADS). TADS used a small computer, three slide projectors, and a rear projection movie screen to display the current tactical situation. One projector displayed a black and white map, another projected the friendly situation in green, and a third showed the enemy situation in red. An intelligence analyst typed intelligence updates into the computer which etched the Army symbol for the activity on a slide and projected it onto the screen at the appropriate point. While appearing "high tech," in reality the system was merely an electronic grease board and did not significantly increase the timeliness of information displayed to the commander and was never operationally fielded.[66] The command and control and timeliness problems continued to get worse. All reconnaissance missions were scheduled at Seventh Air Force Headquarters in Saigon, and all mission results flowed through the same headquarters before ultimately being delivered to the field commander. Maj Barry Fulbright noted that

> the result was that it normally took upwards of five days for a target discovered on a TAC RECCE [Tactical Air Reconnaissance] sortie to be targeted and as much as two weeks for Army requests for mosaics (aerial maps made by "splicing together" numerous individual photos) to be processed and disseminated.[67]

Another attempt to provide timely surveillance information was the use of Army, Air Force, and Marine O-1 Birddog aircraft. These aircraft provided a visual surveillance capability as well as serving in a forward air control capacity. While visual surveillance provided more timely intelligence and was effectively used by close air support aircraft, the information was extremely localized and was not fed into an overall intelligence system in a timely manner. The OV-10 Bronco was specifically developed to support the special needs of counterinsurgency. Designed for maximum visibility and armed with rockets and guns, the OV-10 provided armed reconnaissance support from 1968 until the end of the war.[68]

As the war dragged on, automation and standardization of reporting improved the situation somewhat. Tying together the intelligence centers within Vietnam also helped and led to the linking of in-country centers to higher headquarters and national-level intelligence centers. This unfortunately led to the tasking of tactical reconnaissance assets by higher level authorities and further removed tactical support from the Army field commander. The 460th Tactical Reconnaissance Wing was an example of this problem. The wing was responsible to the commander in chief, Pacific. The Military Assistance Command, Vietnam was merely a customer without command authority over wing reconnaissance efforts.[69]

In the air war, intelligence support improved dramatically toward the end of the war. According to the Red Baron studies of air combat in Southeast Asia, 82 percent of all air-to-air victories during Vietnam were attributable to surprising attack.[70] Preventing surprise was equally important in keeping from getting shot down. To extend the radar picture further into North Vietnam, the Air Force deployed the College Eye Task Force, EC-121Ds equipped with search and height finding radars and identification friend or foe (IFF) capability. In December 1966 a system to interrogate enemy IFFs was added, and in July 1967 a specially modified EC-121K deployed with several crew members who were able to provide near-real-time support by monitoring North Vietnamese electronic emissions and GCI communications. Aircrews were thrilled with the support provided by the College Eye aircraft since that support gave increased warning of MiG activity and resulted in more "bombs on target."[71] Another notable intelligence success story was the use of near-real-time intelligence within the control and reporting post at Monkey Mountain, call sign Teaball. Teaball integrated all available MiG warning information including electronic support measures information from U-2Rs and RC-135s flying over Laos and the Gulf of Tonkin[72] and provided

> real-time MiG warnings to US pilots deep inside NVN. The addition of Teaball produced a dramatic turnaround in the loss ratio of USAF/NVN aircraft. During June/July 1972, the USAF lost three aircraft for every two MiGs destroyed, but after the introduction of Teaball, USAF losses were reduced to about one plane for every four MiGs shot down.[73]

By using the same format as the College Eye aircraft and the naval radar picket ship (call sign Red Crown), the source of the information was transparent to aircrews receiving the combat information. The RC-135s also had the ability to transmit information directly to the aircrews if necessary.[74] This example dramatically demonstrates the kind of force multiplier that near-real-time intelligence support can be. The basis of the success of the Teaball operation was the highly classified Iron Horse system.

> Iron Horse was a computerized system for assimilating and displaying data from Special Intelligence sources. The National Security Agency maintained operational control of the Iron Horse System, but facilities were manned by personnel from the USAF Security Service. The warning advisory function performed by the TACC-NS (Tactical Air Control Center-North Sector) was highly dependent on the information supplied by the Iron Horse computer.[75]

Aircrews gave Teaball high marks for providing tip-offs on threat activity, but the delays caused by the plotting of the data prevented Teaball from providing significant support once an engagement had started, and aircrews relied more heavily on radar information from Red Crown and College Eye. Teaball was also limited by the scarcity of U-2 and RC-135 aircraft available to support operations.[76]

By July 1969, the Southeast Asia Tactical Systems Interface linked the various service tactical data systems into a comprehensive air picture including the ground, naval, and airborne radars of the Air Force, Navy, and Marines and intelligence provided by the National Security Agency.[77] Reflecting on his combat experience in Vietnam, Maj Gen John A. Corder, commander of the Air Warfare Center and director of operations for Coalition Air Forces during Desert Storm, said this capability provided him with essential lifesaving information and is the kind of capability that intelligence must provide to combat aircrews in the future.[78]

While photography still produced a significant portion of tactical intelligence during Vietnam, other intelligence disciplines, such as acoustic and signals intelligence, provided increasing tactical support. Three of the primary reasons for the delay in using tactical SIGINT in Korea and Vietnam were the national level focus of SIGINT collection during peacetime, the lack of aircrew familiarity and training with SIGINT products, and security restrictions on releasing SIGINT information.

Maj Barry D. Fulbright stated in his thesis for the School of Advanced Military Studies, Army Command and General Staff College:

> The Vietnam War was characterized by tremendous improvements in sensor system capabilities, but was plagued by an inefficient and unresponsive requesting and reporting system. Improvements in our night/all-weather capability were of great importance in detecting enemy movements, but the ability to disseminate the intelligence information to the requestor in a timely manner negated much of this improved capability.[79]

The same comments apply to the support to Desert Shield and Desert Storm. It may seem trite, but we keep relearning the same lesson. No matter how good our intelligence product is, it is worthless unless we can get it to the commander in a timely manner and in a usable form. An end of tour report by Lt Col James E. Beitzel, a Seventh Air Force reconnaissance staff officer, accurately reflects Air Force intelligence support to the Army in Vietnam. He stated that while responsiveness to the Army improved, the neglect of this area by the Air Force placed this mission in jeopardy. The Army was on its way to reconnaissance and surveillance self-sufficiency and little evidence was seen that the Air Force should or could counter this trend.[80]

Post Vietnam

After Vietnam military planners agreed that the O-2 and OV-10 aircraft as used in the forward air controller (FAC) role in Southeast Asia to find targets,

identify and mark them for attack, and direct fighter aircraft against them would be extremely vulnerable in a European environment. This idea led to a concept of operations in which the airborne FAC would be moved to a position farther to the rear, would assume a role as a coordinator and radio relay platform, and leave the acquisition and designation of targets to Army forward observers.[81] This concept left a serious gap in Air Force capability to support the AirLand Battle. A joint Tactical Air Command/Training and Doctrine Command reconnaissance/surveillance study group was established to quantify how surveillance/reconnaissance relates to the outcome of the AirLand Battle. The group determined that the critical demand for the 30 existing Air Force and Army systems was to identify the enemy's massed firepower and movement. North Atlantic Treaty Organization (NATO) forces would be fighting heavily outnumbered in a European environment, and there was an urgent need to identify targets with a timeliness and accuracy that would allow NATO forces to attack them.[82]

The Army and Air Force solution was the development of a precision location strike system (PLSS). This system used the TR-1 as a platform for a high-altitude, all-weather, standoff system to triangulate the position of hostile enemy electronic emissions and relay the information to a ground processing station. This ground station would process the information and relay it to strike aircraft or artillery for defense suppression. Brig Gen Richard D. Kenyon, Army deputy chief of staff for operations and plans stated, "It is our doctrine to key upon the command, control[,] and communications elements of the Soviet–Warsaw Pact forces recognizing that they are highly centralized in their control."[83] PLSS suffered from numerous technical problems and cost overruns, and the program has alternately been canceled and revived numerous times. As of this writing, the program has once again been shelved.

Since the Vietnam War we have seen both tremendous successes and serious deficiencies in near-real-time intelligence support to the tactical commander. An example of success is the 1982 Israeli invasion of Lebanon in the Operation Peace for Galilee campaign. Using unmanned aerial vehicles (UAV) equipped with real-time data links, the Israelis located Syrian surface-to-air missiles (SAM) and passed the information on to suppression of enemy air defense aircraft and long-range artillery for destruction. Unmanned aerial vehicles equipped with TV cameras also helped Israeli artillery by assessing and correcting impact points. The Israeli Air Force also stationed UAVs over "three major airfields deep in Syria to gather data on when and how many aircraft were taking off from Syrian airfields."[84] The overall result was the destruction of the preponderance of air defenses and attainment of complete air superiority in one afternoon. As strike aircraft conducted cleanup operations, UAVs provided near-real-time battle damage assessment and surveillance of Syrian ground forces. A British defense expert commented that the Israelis "fought tomorrow's war in Lebanon," and Lt Gen Kelly H. Burke, USAF, retired, stated, "Lebanon was the war of the future—a war in which electronic combat was a central and dominant theme."[85]

US experience in Grenada during Operation Urgent Fury amply demonstrated some of the weaknesses of our current reconnaissance system. In several instances, aircraft taking imagery took several hours to fly home before discovering during film processing that system failures had made their missions futile.[86] Lack of premission coordination and communications interoperability problems exacerbated the problem. At one point the enemy threatened to shoot down a surveillance asset orbiting in the area if it did not leave the area. Intelligence gatherers could not pass on information in a timely manner due to lack of procedures for doing so, lack of precoordination with supported ground and air forces, and communications incompatibility. The joint task force commander, Vice Adm James W. Metcalf, acknowledged that enemy resistance was greater than expected and the lack of timely intelligence was "a serious lesson learned."[87]

The 1986 raid on Libya is typical of the type of operation US forces may be called on to accomplish in the future. This mission involved 119 aircraft and 20 ships.[88] During the nearly eight hours from the time the F-111s took off until their time over target, there was no means to update their intelligence even though reconnaissance aircraft were on-station. The RC-135 on-station supported national intelligence requirements and even supported the Navy carrier group operations, but was not asked and did not provide Teaball-type support to the F-111 attack aircraft or electronic surveillance measures (ESM) support to EF-111 jamming aircraft involved in the operation.[89] Considering the elusiveness of terrorist and guerrilla targets, eight hours is an incredibly long time without update information.

Desert Storm

While many of the intelligence lessons learned from Desert Storm are still classified, a few are not. Gen H. Norman Schwarzkopf, commander of US Central Command and coalition forces during the war, told the Senate Armed Services Committee, "We just don't have an immediately responsive intelligence capability that will give the theater commander near-real-time information that he personally needs to make a decision." He specifically referred to a serious lack of timely imagery for aircrews' use during mission planning and execution at the tactical level. His view is that we "focus too much on what might be called national systems, which respond more to . . . Washington." During the same hearing, Senator J. James Exon (D-Nebr.) quoted Adm Frank B. Kelso, chief of naval operations, as saying, "One of the things we need to improve is real time tactical intelligence and the ability to distribute it."[90] The interim report to Congress on the conduct of the war listed a requirement for better imagery reconnaissance at all levels, a battle damage assessment system that was slow and inadequate, and the need for better secondary imagery transmission systems as shortcomings within intelligence. In addition, one critic of tactical intelligence during Desert Storm alleged that:

> Pre- and post strike imagery was available throughout the war, piling up in a corner somewhere in the tactical air control center because the tactical leadership has never given much thought to how tactical reconnaissance is effectively employed and integrated into the package.[91]

Perhaps the best summary of the problems that General Schwarzkopf and Admiral Kelso brought up is that "broad area, all-weather, search/surveillance systems are required to improve the intelligence available to tactical commanders."[92] That is not to say that there were not some spectacular intelligence successes in the war.

The Joint Surveillance Target Attack Radar System (J-STARS) proved extremely effective in monitoring the movement of Iraqi armor and logistic convoys. The near-real-time combat information it provided allowed a steady stream of F-15Es to take full advantage of their deep-strike, night capability. The Army used near-real-time targeting information from J-STARS to target and destroy a SA-8 surface-to-air missile battery using a multiple launch rocket system battery. J-STARS mobile ground stations were available to the Air Force Tactical Air Control Center, Army Forces Central Command Forward and Rear, Marine Forces Central Command, and the Army VII Corps and XVIII Airborne Corps. As ground component commanders became more familiar with J-STARS capabilities, they used it more and more, often tasking it on a real-time basis while airborne.[93]

Unmanned aerial vehicles provided targeting information for the Navy and Marines, and Lt Gen Charles A. Horner, the air component commander during Desert Storm, has recommended that the Air Force look at fielding a squadron of UAVs to provide tactical intelligence support to close air support and battlefield air interdiction operations.[94]

Links between reconnaissance/surveillance aircraft RC-135/J-STARS/airborne warning and control system (AWACS) and command and control aircraft (AWACS/airborne battlefield command and control center [ABCCC]) enabled these aircraft to share radar and intelligence information. Near-real-time information from these platforms provided updated targeting information, Iraqi Air Force activity, and hostile surface activity and made significant contributions to search and rescue efforts for downed aircrews.[95]

According to Gen Donald J. Kutyna, commander in chief, US Space Command, "Desert Storm was the first campaign-level combat operation where space was solidly integrated into combat operations" and that "space-based surveillance systems were on-scene and available to our theater forces from the moment the crisis began until the last shot was fired."[96]

Summary

The increasing pace and intensity of combat operations has driven the intelligence requirement for faster and faster intelligence. We enter each conflict with reconnaissance capabilities left over from the previous conflict. Intelligence communications architectures are not designed to provide timely

support to tactical operations until work-arounds are developed. The six months' preparation we were allowed during Desert Shield allowed operations and intelligence personnel to learn many lessons before Desert Storm was initiated—a luxury we cannot anticipate in future conflicts. Writing at the Air War College, Col Richard L'Heureux concludes that due to uncommited leadership, budget restraints, mission rivalries, and uncoordinated development and acquisition, US tactical reconnaissance is a "hodgepodge of 'stove-pipe' systems unable to meet the requirements of modern high intensity warfare." While the DOD and services have given lip service to interoperability, program directors are easily distracted when developing systems to support service objectives.[97]

We have come a long way in improving our sensor technologies and our ability to view the modern battlefield. What is left to develop is the ability to provide a common view to all required levels in all kinds of conflicts in a timely and accurate manner. Chapter 4 addresses who the consumers are for this tactical combat information, what our current shortfalls are, and the requirements of the various intensities of conflicts.

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Chapter 4

Problems and Shortfalls of Combat Intelligence

One of the shortcomings we found is that we just don't have an immediately responsive intelligence capability that will give the theater commander near-real-time information that he personally needs to make a decision.

—Gen Norman Schwarzkopf

Norman R. Augustine, chairman of the Defense Science Board, stated in 1982 that the challenge to technology and modern air power was not in delivering more ordnance, but in finding and hitting the target.[1] Our current intelligence and reconnaissance systems fall short of this challenge, not because of a lack of technology, but because of a lack of a coordinated focus on support to the tactical consumer. This is not a new development. Throughout the history of air power, airborne reconnaissance and the systems required to process the intelligence collected have suffered from a lack of support during peacetime, uncoordinated and competing technologies, and an inability to keep pace with operational requirements and the threat.[2] Writing about the selection of reconnaissance aircraft in World Wars I and II, a historian at the Air War College noted:

> In each war the modified aircraft which finally became more or less "standard" in reconnaissance were selected by a process akin to the trial-and-error method. In neither instance did the United States, prior to combat, have well defined reconnaissance concepts contemplating the employment of specific and proven reconnaissance-type aircraft.[3]

Despite some recent successes in Operation Desert Storm, we find ourselves not too far removed from this assessment today. The Mach 3+, high-flying strategic reconnaissance SR-71 has been retired, the tactical reconnaissance RF-4C is rapidly being phased out, and no system has been fielded to replace either one. During Desert Storm the Air Force had a requirement for six squadrons of RF-4s, but was only able to muster one and one-half squadrons from the reserve components. Aircraft normally assigned four to five targets per mission were assigned as many as 30 targets per mission.[4]

Col Richard J. L'Heureux, Twelfth Air Force director of intelligence, while at the Air War College wrote that it appears we have the numbers and variety of reconnaissance systems needed, but in reality our

> systems are not sufficiently integrated, rely on oftentimes fragile communications and are in general unsuitable for timely dissemination of critical information to large numbers of potential users.[5]

He described our current tactical reconnaissance capability as a "hodgepodge of systems" poorly designed to support the rapid maneuver warfare described in the Army's AirLand Battle doctrine and the North Atlantic Treaty Organization's (NATO) follow-on forces attack, and only marginally suited to low-intensity operations in third-world areas having limited basing support.[6]

Strategic versus Tactical Focus

One of the primary problems facing US reconnaissance systems in attempting to provide tactical support to the war fighter is that these systems were not designed to support the tactical commander. The predominance of the strategic mission of the Air Force and the glamour of "black world" reconnaissance programs, such as those developed in the famous Lockheed "Skunk Works," strongly influenced the reconnaissance development of the 1950s and 1960s. (The "Skunk Works" developed several aircraft whose very existence was unknown to the public until the aircraft had been operational for several years.)

The Air Force, particularly Gen Curtis LeMay, attempted to regain control of the reconnaissance mission from the Central Intelligence Agency, starting with the development of the U-2 and later with the emerging space programs, but to no avail. President Dwight D. Eisenhower strongly believed in civilian control of the military and believed that allowing the military to control the intelligence systems that supported the development of weapon programs would be self-serving and play into the hands of the military-industrial complex.[7]

By the middle of the 1970s, the United States intelligence structure was primarily controlled by national agencies. Strategic Air Command operated strategic air assets under the control of national agencies. Communications between the national agencies and the military was ineffective. The military's organic tactical assets were obsolete, having suffered from neglect in the budgeting process.[8] During peacetime, intelligence typically does not trickle down to the operational and tactical levels until the national intelligence centers have analyzed it and produced it as a fused intelligence product agreed on by the consensus of intelligence analysts. This process can take from a few days to a few months. This focus of peacetime intelligence has created the stovepipe intelligence architecture that we have today—a system of few-of-a-kind airborne assets, national production centers, theater-level fusion centers, some organic tactical assets, and other national technical systems that are responsive to Washington, but not necessarily to the war fighter.

Air Combat Command has ownership of the U-2, TR-1, and RC-135 aircraft, but mission tasking still comes from national agencies. These national collectors and agencies provide indications and warning, intelligence estimates, and collection, analysis, and production of all the intelligence disciplines in support of national-level consumers (president, State Department, etc.). Their emphasis on support to tactical operations has languished. Due to their size, cost, and

technical requirements, most of these collection and production systems are physically located far from the tactical consumer.[9] These limitations prevent some national systems from deploying to the theater of operations and make them dependent on fragile communications systems to deliver their intelligence to the field.

The reduction-in-force levels that occur periodically between wars has exacerbated the problem and caused the Air Force to "think in terms of worldwide intelligence rather than battlefield surveillance. This in essence degraded the needs of the ground commanders and relegated their reconnaissance priority to a lower level."[10]

Gen Norman Schwarzkopf, commander of the coalition forces during Desert Storm, commented that there was a problem of discrepancies between battle damage assessment provided by the national intelligence agencies and local assessments within the theater during Desert Storm. He based his recommendation to start the ground offensive primarily on estimates developed within the theater.[11]

The possibility of terrorist attack or special forces actions against these unique high-visibility collection/production systems is a real possibility. The Tactical Reconnaissance System (TRS), consisting of the TR-1 aircraft, its radar and electronic sensors, and its associated ground station, is an example of a possible target. Because the system is tethered by data link to a hardened ground station, it has limited range and flexibility. Destruction of the ground station would prevent exploitation of the data collected.

The Tactical Exploitation of National Capabilities Program is a step in the right direction, but true incorporation of national systems into the tactical reconnaissance system has been slow and marginally effective. A congressional report stated that the services have paid scant attention to these programs and that these programs are currently suffering from small budgets and neglect from senior Department of Defense officials.[12] Congress has also ordered the chairman of the Joint Chiefs of Staff to provide use of national intelligence collection systems and exploitation organizations in joint exercises to ensure that these systems and organizations are capable of supporting future combat operations or threats to national security.[13]

Traditionally considered a national asset, RC-135 Rivet Joint aircraft have recently become more involved in tactical operations and are now routine participants in Air Combat Command's Green Flag exercises. Green Flag has been instrumental in the efforts to incorporate national systems into tactical operations. The exercises provide a training forum where former Tactical Air Command and Strategic Air Command aircrews get together to develop tactics and procedures for improving national systems' support to tactical operations. A Senate Armed Services Committee report praised the performance of Rivet Joint aircraft during Desert Storm in providing critical dissemination and display capabilities through the Tactical Information Broadcast Service (TIBS). Their praise was tempered by comments that despite the RC-135 successes, the aircraft's capability to disseminate tactical information to the tactical forces is limited because of the prototype configuration and small

number of TIBS terminals available.[14] The U-2 and TR-1 also were credited with contributing valuable intelligence information "although the information was not always timely."[15] The Air Force is developing a contingency airborne reconnaissance system to enable the TRS to support tactical forces better, but initial operational capability is still in the future.

Independent Collection Systems Development

Independent development of reconnaissance systems strictly within the reconnaissance and intelligence communities has led to systems that some people have referred to as self-licking ice-cream cones, in that they are impressive, but only provide intelligence to other intelligence organizations and are of limited use to anyone else. Even Headquarters USAF describes our current situation as a "collage of multiple systems" with "manual processes" and "separate SIGINT, IMINT, scientific and technical & analytical groups."[16]

Future tactical intelligence improvements must be in response to an operational mission. This linkage between the supported mission and supporting systems must be made or intelligence will continue to be unresponsive to the tactical commander's requirements.

The black or clandestine reconnaissance programs of the past have achieved tremendous individual successes, but their black-world development has worked against integrating these systems with other reconnaissance systems and the command, control, communications, and intelligence architectures that they must support if they are to be viable tactical assets. In maintaining a cloak of secrecy, clandestine developers mask information regarding sensors, data links, ground stations, and other associated technologies from the rest of the world that these systems must be able to work with once they become operational.[17]

To be effective and efficient, sensors need the ability to cross-cue one another, to alert or focus another sensor to the existence or location of a target. During Desert Storm, the Joint Surveillance Target Attack Radar System was able to cross-cue unmanned aerial vehicles (UAV) operated by the Marines. This allowed the Marines to pinpoint Iraqi defenses and monitor troop movements, but it was not a planned interface and used UAVs that the Marines needed elsewhere.[18]

The independent development of single-sensor systems has also led to systems that generally are unable to easily cross-cue other sensors or reconnaissance systems. The incorporation of multiple sensors on one platform able to cue each other, or separate systems able to cue each other within a combat information system, provides a synergism that capitalizes on individual strengths of the various systems and downplays weaknesses. For example, SIGINT systems generally can provide timely warning information, but initially can provide only coarse positional information until numerous intercepts have been made. Imagery systems provide detailed positional information, but

have difficulty surveying large areas. Providing rough positional information from SIGINT sources to IMINT systems greatly enhances the speed and accuracy of the overall intelligence system as well as providing a measure of confidence against deception.

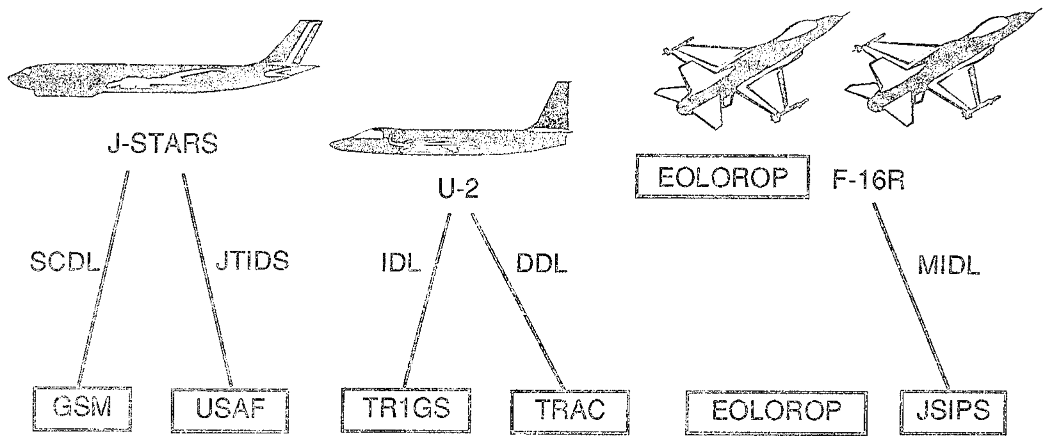
The independent development of reconnaissance systems has also left us with little commonality between systems, and the opportunity for "integration among the various sensors carried by FOTRS [follow-on tactical reconnaissance system], TRS, and Joint STARS platforms seems to be fairly minimal."[19] The development of varied technologies by the various manufacturers and program offices has left us with suites of electro-optic, infrared, advanced synthetic aperture radar, and moving target indicator "sensors mounted on platforms of very different size and performance characteristics."[20]

The FOTRS program requires commonality of sensors for the pod-mounted and internally mounted systems to be carried on the RF-X, F/A-18, F-14D, and UAVs. This is an important first step, but even this program does not require commonality of sensors within the NATO effort. Instead, this program is attempting to standardize data links and recording operations so that NATO allies and the US can exploit the information with the use of reformatting systems to convert the digital data from one country's system to another.[21]

The number and diversity of data links in operation in US command and control, reconnaissance, and weapons delivery systems has created a nightmare for those trying to establish commonality of systems (fig. 3). The data links for the FOTRS (the miniaturized interoperable data link [MIDL]) and TRS (the interoperable data link [IDL]) systems are not compatible even though they are built by the same manufacturer—Unisys. The TRS also uses a digital data link (DDL) to send information to the Army ground processing station. J-STARS uses two narrowband two-way data links—the Joint Tactical Information Distribution System for the Air Force and the surveillance control data link for the Army, neither of which is interoperable with the MIDL to be used with the FOTRS system. The J-STARS program manager has been directed to explore the feasibility of developing a common data link with NATO standoff systems, but there is no requirement to make it interoperable with other US imagery systems.[22]

In an attempt to control this proliferation of different systems, Gen Bernard Randolph, commander of Air Force Systems Command, directed that a program be instituted to ensure commonality and compatibility of USAF data links. In 1989 he endorsed the recommendations that the Electromagnetic Compatibility Analysis Center be made a clearinghouse for information on available data links, that program managers not develop new systems when current or modified systems would suffice, that a military standard for formatting information on data links be established, and that ways to ensure the modularity among data links be investigated.[23]

The ground station interoperability problem is also serious, but shows more promise than other areas. The Joint Service Imagery Processing System (JSIPS) will ultimately be able to process the full range of imagery systems to include electro-optic, infrared, advanced synthetic aperture radar, moving target



Legend:
DDL—digital data link
EOLOROP—electro-optical long-range oblique photography
GSM—general support maintenance
IDL—interoperable data link
JSIPS—joint service imagery processing system
J-STARS—joint surveillance target attack radar system
JTIDS—joint tactical information distribution system
MIDL—miniaturized interoperable data link
SCDL—surveillance control data link
TRAC—tactical reconnaissance air center
TR1GS—TR-1 ground station

Source: Col Richard J. L'Heureaux, "Tactical Reconnaissance: Opportunities Through Integration," defense analytical study (Maxwell AFB, Ala.: Air War College, 1990), 39.

Figure 3. Imagery Data Link Systems

indicator, and synthetic aperture radar and will be compatible with J-STARS and TRS. One recent disappointment is the independent development of the electro-optic long-range oblique photography system initiated as a reaction to complaints generated during the Grenada operation in 1983. This electro-optic system does not require the extensive ground processing equipment that film-based systems do, but it does not have a data link and must return to base to process the imagery. There was no contractual requirement for compatibility and commonality with the FOTRS program already under development, and the contractor chose to select a completely new recording system. The Air Force is now trying to go back and modify the contract to correct this problem.[24]

The TRS has two types of ground processing systems. The Air Force uses a hardened underground facility and is developing a deployable system called the Contingency Airborne Reconnaissance System. The Army chose to go with a mobile tactical reconnaissance Advanced Synthetic Aperture Radar System (ASARS) correlator that reformats the ASARS-2 imagery to allow the Army JSIPS to process the information.

The Army and the Air Force have demonstrated very different philosophies in the development and deployment of ground stations. The Army prefers to deploy larger numbers of relatively low-cost, smaller systems to lower echelons. The Air Force tends to develop large, centrally based, fixed sites to support the tactical air commander and the upper echelon of the tactical air control system.

Joint Service Issues

The history of tactical air reconnaissance shows a significant trend that, despite our best efforts, the Air Force continues today. We provide centralized reconnaissance that tends to emphasize support to the air component at the expense of the ground forces. This emphasis has led to the perception among the other services that the Air Force does not adequately support the ground commander's intelligence requirements.

The causes of this emphasis range from budgetary constraints to a national strategy of nuclear deterrence, but the result is that the senior leadership of the Army has lost confidence in the Air Force's resolve and ability to provide timely intelligence support to the tactical ground commander. In an address to the Air War College in January, 1990, Lt Gen Calvin A. H. Waller complained that reconnaissance information reached the corps too late to be of any value and requested that the Air Force establish a downlink direct to the corps' intelligence center.[25]

For effective synchronization of air and ground forces in the AirLand Battle, the tactical reconnaissance cycle must also reflect this tenet of synchronization. "Target selection and prioritization is a shared responsibility of the air and land force commanders, based on the overall guidance of the joint force commander."[26] To meet this shared responsibility, the Air Force and Army must have near-simultaneous access to near-real-time information. The *Air Land Bulletin* stated that while "the current airpower apportionment and allocation processes are valid and dynamic," there is a greater need at the corps and division headquarters for Air Force planning. New technologies are needed to provide responsive air interdiction and decentralized close air support.[27]

In response to the real or perceived reduction in tactical reconnaissance support, the Army developed a new organizational structure to provide tactical intelligence to the ground combat commander. Intelligence support for the Army combat commanders is provided by combat electronic warfare and intelligence (CEWI) units. The combat electronic warfare intelligence organizations developed by the Army have been criticized from within the Army as being "large, complex intelligence units" that are "very vulnerable targets" and do not "deliver the required intelligence to the combat commander."[28] The CEWI system fails to integrate national systems, is not timely, and lacks flexibility. During a Reforger exercise in Europe, a CEWI brigade commander confessed that 95 percent of the information he got came

through a jury-rigging of the system and that he relied on a single-source collector and processor.[29]

The AirLand Battle doctrine espoused in FM 100-5 calls for synchronization of air and land forces. Historically, forces have not achieved synchronization, but deconfliction, or at best—coordination. During Vietnam and Operation El Dorado Canyon, naval and air forces divided their air power into sectors to deconflict targets and prevent aerial fratricide. During Desert Storm, air power under US Air Forces, Central Command commander Lt Gen Charles A. Horner went much further in establishing coordination and deconfliction of air power under one "Air Boss," but still did not achieve true synchronization of air and land power. This synchronization is of increasing importance as more and more of the traditional Air Force missions become joint endeavors.

Interdiction

The Army has an increasingly more important role in interdiction, or fighting the deep battle, traditionally an Air Force role. The Army is well along in developing the weapons to fight the second echelon forces, but lags the Air Force in its ability to "see" those second echelon forces. The fiber optically guided missile (range in excess of 10 kilometers [km]) is used against tanks and helicopters; the smart multiple launch rocket system (range in excess of 30 km) is used against weapon-selected point targets; and the Army Tactical Missile System (range in excess of 100 km) all require near-real-time intelligence that the Army cannot provide.[30] Similarly, the Army's Apache helicopter can be employed 150 km into enemy territory and has an intelligence requirement that extends at least 200 to 300 km into enemy territory. This requirement for close cooperation and communication was vividly demonstrated in Iraq in 1991.

> During Desert Storm elements of the 101st Airborne Division (Air Assault) penetrated 90, then 150 miles into Iraqi territory in brigade size assaults. As long as the lines on the maps remain connected everyone understands, at least conceptually where CAS, Battlefield Air Interdiction (BAI), and Air Interdiction fit into the game plan. Problems appear when large troop formations appear well past the FEBA and the call goes out for CAS.[31]

When the range of the integral sensors limited Army and Air Force weapon systems, the targeting problem was simpler. The increased range of battlefield surveillance systems further clouds the distinction between "targeting" and "intelligence" systems. As both the Army and Air Force develop longer range weapon systems, the question of who commands the deep battle, or interdiction effort, becomes a more contentious issue. Currently the Air Force has the primary responsibility for fighting the deep battle, with coordination from the Army. The intelligence for planning sorties, both attack and reconnaissance, at the tactical air control center level must focus on the operational level of warfare, determining the enemy's center of gravity and

how to destroy it. According to Air Force Chief of Staff Gen Merrill McPeak, the battlefield coordination element (BCE) is responsible for coordinating battlefield air interdiction on either side of the fire support coordination line. Also the BCE should ensure that the air and ground commanders share "congruent views" of the battlefield and that each commander knows the near-, mid-, and long-term objectives of the other so that a temporary break in communications will not disrupt operations.[32] To share this congruent view of the battlefield and develop synchronous plans of actions, the Army and Air Force must share a common intelligence picture to include common data bases, compatible collection and reporting systems, and standardized displays.

The rapid execution of maneuver warfare creates additional requirements for near-real-time operations/intelligence information at the tactical level. The Army recognizes this problem and the potential solution. Lt Gen Billy M. Thomas, the Army Materiel Command's deputy for research, development, and acquisition, stresses that "Desert Storm was fought on an electronically intensive battlefield" and that future systems "will allow commanders to cut through the chaos of war and see the battlefield electronically in real or near-real-time." He advocates development of a "system of systems" to integrate all of the future Army electronics and to allow the tactical commander a graphic electronic depiction of the battlefield encompassing both friendly and hostile forces.[33] The Army's senior leadership has established this system as one of the Army's future key operational capabilities to be developed.[34]

Offensive Counterair

History strongly indicates that air superiority must be the primary goal for any air force. Initially this battle for air superiority was fought exclusively in the air, but with the advent of ground-based air defenses and especially the increasingly sophisticated modern, mobile, guided threats, the battle for air superiority has expanded to include the suppression of ground-based enemy air defenses.

Col John A. Warden III, in his book, *The Air Campaign: Planning for Combat,* described the three factors that affect the air superiority campaign as materiel, encompassing aircraft, surface-to-air defenses, and the supplies and infrastructure for their support; personnel, including aircrews and specialized support personnel; and position, including the location of air bases, air defenses, and enemy troops.[35] While air bases and their supporting infrastructure do not present insurmountable intelligence challenges, the dispersal of aircraft into widely scattered geographic areas, including civilian population centers, does present an intelligence challenge. The mobile air defenses supporting maneuver elements of an enemy army also pose a significant threat to our ability to achieve air superiority. Mobile air defenses also challenge the intelligence system not only to keep up with the current location of threat emitters, but to determine which old locations are no longer active.

Air Defense

Another area of increasingly joint Army/Air Force responsibility is air defense. Airspace control is exercised through positive and procedural methods. Positive control relies on electronic systems and command and control aircraft for identification and tracking of friendly and hostile aircraft within the designated airspace. Procedural controls include minimum risk routes, weapon engagement zones, air corridors, and airspace control areas.[36] These procedures significantly reduce the flexibility and effectiveness of Army and Air Force systems and are increasingly difficult to manage as both ground and airborne missile systems have longer and longer ranges.

Historically, air defense system responsibilities have been physically separated into distinct operational areas/zones to reduce the potential for misidentification and fratricide or "friendly fire." As Maj Gen Michael Nelson, assistant chief of staff, Supreme Headquarters Allied Powers Europe, explains, "Procedural and visual identification systems are simply inefficient, unreliable, and inadequate" and "current electronic identification systems are easily spoofed or jammed and sort out only those aircraft not responding, for whatever reason."[37] These conditions and the separation into zones result in an estimated 25 to 60 percent decrease in air defense effectiveness in NATO.

The separation of ground and airborne air defenses allows an enemy to attack the air defense system piecemeal, first suppressing our surface-to-air missiles and then attacking the defensive counterair aircraft. These procedural constraints also limit the battlefield air interdiction, defensive counterair, and close air support available to rapidly maneuvering ground units prosecuting the "deep battle" as the front lines become blurred and there is no reliable way to continuously update geographic lines of responsibility.[38]

Equipment malfunctions, coding problems, and multinational forces complicate the electronic identification problem. Syrian forces relying strictly on identification friend or foe to distinguish between Arab and Israeli aircraft in the 1973 war destroyed as many Arab aircraft as Israeli aircraft and reportedly caused 15 to 20 percent of total Arab aircraft losses.

The application of air power in Desert Storm suffered minimally from these restraints because we had virtual air supremacy from the opening moments. In the few instances when the Iraqi Air Force rose to challenge Coalition forces, the intelligence system detected, identified, and targeted the enemy aircraft before they could reach their target. The rarity of such occurrences made them stand out and the intelligence system had the resources and time to focus on them. Given an efficient, dedicated enemy that mounts a significant counterair campaign, our intelligence system would be overwhelmed attempting to detect and identify the hostile air threat.

A solution to the problem of real-time identification of friend versus foe is under development by the Army and the Air Force. It is a concept of a joint engagement zone (JEZ) where either ground or airborne systems can target a hostile fighter. The rules of engagement in this JEZ will be based on having a positive hostile identification. This means that to engage a target, the shooter

must have more than a lack of a friendly response—indeed must have confirmation from some source that the target is hostile. Positive hostile identification (PHID) will come from cooperative and noncooperative target signature systems, observance of a hostile act or intent, or off-board verification of target attributes (e.g., visual identification or point of origin determination). The target signature systems use radar, optical, infrared, acoustic, and electronic support systems to identify enemy aircraft. The Patriot and Hawk surface-to-air missile systems and certain airborne platforms already have organic PHID systems.[39]

The Air Force is developing the command, control, and communications (C^3) architecture for the distribution of PHID combat information. This C^3 architecture has potential applications for other mission areas besides air defense. According to the Joint Air Defense Operations/Joint Engagement Zone, Joint Test and Evaluation Program Plan:

> Platforms and systems having PHID capabilities would be tasked to input voice and datalinked information to central C^3I nodes; ie, CRCs [control and reporting centers], AWACS [airborne warning and control system], and/or ground AD [air defense] brigade fire direction centers (in contingency operations). Data will be correlated/fused at these control nodes and engagement commands will be sent to appropriate AD elements. Additional target signature systems will be used to "interrogate" targets when a single system is unable to positively identify a target as hostile.[40]

Fratricide

One of the greatest concerns on today's mobile battlefield is the problem of fratricide. The problem is not limited to fratricide of aircraft. According to a study by the Army Combat Studies Institute, during World War II, Korea, and Vietnam, casualties from friendly fire amounted to approximately 2 percent of all casualties. During Desert Storm, 17 percent of all US casualties and 77 percent of all Army tanks and Bradley fighting vehicles lost were the result of fratricide! Analysts attribute this higher loss rate to the "intensity of modern manuever warfare" and contend that if the war had lasted the two to three weeks that General Schwarzkopf had predicted and losses had reached the expected several thousand casualties, friendly fire losses would have comprised a significant portion of the total losses. The rapidity of movement, the difficulty of identifying ground forces compounded by a coalition of 28 countries, and the incompatibility of communication systems led to the inevitability of fratricide. The worst incident occurred when US A-10s mistakenly attacked a column of British Warrior armored vehicles parked in the Iraqi desert. The A-10 pilots believed that they were in the right place, and the British forces believed the US pilots knew who they were.[41] This incident took place in open desert with no electronic jamming or hostile firing at the aircraft. In a postwar assessment, the Pentagon reported that despite five months' preparation and efforts to mark coalition fighting vehicles, "the procedures and materiel used by coalition forces were only marginally effective,"

and "we have yet to devise a cost effective approach to achieving improved identification procedures."[42]

Joint Intelligence Shortfalls

Coalition forces discovered during Desert Storm that "the development of joint operations doctrine has outpaced the development of supporting intelligence doctrine."[43] The reorganization of the services under the Goldwater-Nichols Act redirected intelligence information to support the war-fighting commander in chief (CINC). Prior to that, "intelligence tended to be directed to the Service component or retained at the national level."[44] Allied forces learned several lessons from this change. There was a need to "refine the joint intelligence center (JIC) doctrine to support the theater Commander-in-Chief" to enhance joint war-fighting capabilities. Also "all the services and agencies must deploy with compatible intelligence dissemination and communications systems."[45] Additionally, the joint CINC was "not staffed or equipped to handle the volume of raw and finished intelligence data he received, or to manage the intelligence assets he was allocated."[46] In developing the joint intelligence doctrine to support the theater CINC, we must address the joint intelligence requirements and not focus on service-specific needs. We must develop systems and procedures that support the operational level of war while still supporting the tactical commander, and ensure that the collection, correlation, and fusion of intelligence are timely. The resulting information must be presented in a usable format.

Another often-ignored area of interservice cooperation is intelligence information provided by the Army to the Air Force. The organic reconnaissance assets the Army uses to support its various echelons could provide a significant boost to the Air Force's collection effort. During Desert Storm there was an instance where an A-10 wing went begging for current intelligence from the tactical air control center (TACC) to support the Army, while a collocated Army RU-21 unit did not provide the wing with any information.[47] At other points, the TR-1 was unable to get airborne due to high winds or the J-STARS was delayed in taking off. The Army corps commanders were able to fill the gap with OV-1D aircraft, but not without considerable debate.[48] This lack of cooperation and coordination is not so much the result of parochial infighting between the services as a lack of awareness of needs and capabilities, the lack of an established system to cross-feed information, and the lack of training and exposure in peacetime. According to one intelligence officer in Desert Storm, the Marine Corps was "the poor man on the block" when it came to reconnaissance capabilities. The Marines relied heavily on the other services for long-range reconnaissance, while using unmanned aerial vehicles for the closer look.[49]

Limited Number of Platforms

Another result of the Air Force's emphasis on large, expensive, few-of-a-kind sensors is that very few reconnaissance assets are available to the tactical commander. There are only about a dozen RC-135s and less than 50 TR-1s. The RF-4 is about to retire without a fielded successor, and Joint STARS is not scheduled for initial operational capability until the mid-1990s. The F-16s being modified for the reconnaissance role will not be operational until the late 1990s.[50] The UAV Advanced Tactical Air Reconnaissance System (ATARS) payload is not scheduled to be operational until 1996–1997, and then the Air Force will only field 110 systems and warehouse another 150.

Military officials involved in the program are concerned with the limited number of JSIPS terminals that will be available to receive the data-linked information. Because JSIPS terminals are going to be "somewhat rare," data dumps will have to be coordinated so as not to interfere with each other, because UAVs cannot loiter for a long time and cannot be reprogrammed in flight. If unable to data link the information, the system will rely on playing back the videotapes after the UAVs are recovered.[51] This fall-back option is not any more timely than today's system. Moreover, the lack of redundancy of systems could lead to serious gaps in intelligence even if only a few of the reconnaissance platforms are destroyed or degraded. If for no other reason, the limited number of systems should drive the intelligence community to strive for greater joint cooperation.

Line-of-Sight Limitations

Airborne reconnaissance systems suffer from line-of-sight problems in two circumstances. The first is that most collection systems require line of sight to the target to collect the sought after signal or imagery. This means that standoff systems must fly at extremely high altitudes. Even at high altitude, high terrain can mask the target and severely limit the range of collection. If the conflict occurs out of the line-of-sight range of the data-link capability to the ground station, the collection platform must either store the data until it returns closer to the ground station or must have a satellite relay capability. Penetrating tactical reconnaissance systems have the same line-of-sight problems. Flying nap-of-the-earth profiles to avoid threat detection and defenses, penetrating reconnaissance platforms (e.g., the F-16R or unmanned aerial vehicles with the ATARS pod on board) will have to "pop up" to achieve line of sight to data link their information back to their ground stations.

Timeliness Problems

For intelligence to be valuable it must be timely. This is an area that has been addressed by many systems developments and procedural changes, but which still ranks as one of the most vexing problems. The World War II method of attaching reconnaissance assets to the supported ground commander helped to solve the timeliness problem, but proved to be a very inefficient way of distributing air power which needs centralized control. In Vietnam, reconnaissance was centralized, but "the reporting system often took several days to get the intelligence to the commander."[52]

Desert Storm tactical and national intelligence were characterized by long time delays, and senior commanders complained that battle damage assessment never caught up with the frantic pace of high-technology maneuver warfare.[53] Even before the start of hostilities, commanders had identified communication limitations and poor joint operations reporting procedures. The close physical siting of multiple processing centers partially overcame the problem, but at the risk of placing many lucrative targets close together.[54] Against a more sophisticated adversary, this solution could have proved devastating to our collection and analysis capability.

A report to Congress emphasized that the incompatibilities of the various systems fielded by the services were difficult to overcome and "although field expedient solutions were developed, it was often at the expense of timeliness."[55] For example, the computer system used by the Air Force for battle planning was incompatible with Navy systems, and information had to be hand-carried to the Navy ships.[56] Frank Kendall, deputy secretary of defense for tactical warfare programs, commented that precision guided munitions "would have done better if surveillance and targeting had been better" and that information did not reach operational units fast enough to "hit targets that may not be there in an hour, a half-hour, or 15 minutes."[57] The key point is getting the information to the operational unit or shooter.

Oftentimes reconnaissance or command centers were able to view events in near real time, but were unable to get the necessary combat information to the tactical war fighter in time to be of value. Air Force Chief of Staff General McPeak said that the next best thing to having an intelligence sensor on the fighter aircraft was to have it on a dedicated theater aircraft such as the J-STARS or AWACS. He continued that the more detached the sensor system is from the fighter aircraft the less efficient the system becomes.[58]

Previously, exercises in Europe had experienced time delays on the average of four and one-half hours from the time a reconnaissance aircraft imaged the target until the tactical ground commander received the information. Delays with the communication system took almost three and one-half hours of this time.[59] As the volume of information collected and analyzed increases, the burden on the communication system increases. Voice and message traffic already consume vast amounts of the existing communications capability and digital imagery transmission systems consume high volumes of communications

capacity as well. During Desert Storm, the flow of imagery from processing centers in the US to combat units in the Persian Gulf inundated the Defense Satellite Communications System.[60]

Table 3 demonstrates the range of values and expected times within the conventional reconnaissance system. It is easily seen that communication transmission time is by far the most serious impediment to providing timely tactical intelligence.

Table 3

Conventional Reconnaissance System Time Lines

Node	*Actual Time in Minutes*	*Expected Time in Minutes*
Flyback	10–40	30
Download/Processing	2–10	8
Exploitation	7–60	18
Communication Transmission	30–300	200
Total Time to Decision Makers	51–420	261

Source: Adapted from Maj Mike Poore, "Integrating New Technology Into the TAC RECCE Cycle," *Journal of Electronic Defense,* May 1986, 56.

System Overloads

Two major dangers are associated with collection of intelligence and combat information. The first is the inability to get all the required information. Carl von Clausewitz in *On War* described this problem as the "fog of war" and stated that "many things on the battlefield are unknown and will remain unknown."[61] The other danger is that more information may be available than the commander can comprehend. As stated in AFM 1-1, *Basic Aerospace Doctrine of the United States Air Force,* "Finite reconnaissance capabilities must be used carefully to gain an optimum—rather than a maximum—amount of useful information."[62] Given the huge volume of information today's sensors can provide, it is essential that this information go through some filtering process. How much information and how fast the commander gets it depend on the data automation available and/or how the system is designed to correlate, fuse, and filter the tidal wave of information entering the system.

A significant technical challenge for the tactical intelligence community is the requirement to overcome the analysis bottleneck for the tremendous volume of information that is needed and being collected. Intelligence has relied on sophisticated technical solutions to the problems of sensors and communications, but often still relies heavily on the "judgment, experience, and other cognitive processes of the individual performing the function" of analysis.[63] This is the "art" of the "art and science" of intelligence. The correlation and fusion process is still heavily personnel intensive, and the quality of the results depends on individual capabilities and the teamwork fostered in a tactical environment. The sheer volume of data to be analyzed can be overwhelming.

For example, a Soviet front consisting of four armies would have roughly 280,000 troops and 80,000 major items of equipment or targets that need to be located, identified, tracked, and assessed by friendly intelligence systems and their analysts.[64]

The Iraqi forces arrayed against coalition forces during Desert Storm were of similar magnitude.

In Vietnam the reconnaissance effort suffered, not so much from a lack of sorties available, but from not having enough imagery interpreters to exploit the film available. Typically, interpreters exploited only 20 percent of the film.[65] New electro-optic imagery systems are not limited by the requirement to use film, and the amount of imagery they are able to produce is virtually unlimited. While many systems produce imagery that does not need a trained imagery interpreter, much of the imagery produced still requires unique skills to convert the raw images into usable combat information. As the number of tactical reconnaissance squadrons decrease and the total force dwindles, there will be an ever-increasing need to automate this process and relieve the burden on the analyst.

Security Access

Security access problems today include two separate areas. The first area is the compartmentalization of much of the intelligence gathered on a day-to-day basis to protect the sources and capabilities of US intelligence systems. Information must be sanitized (stripped of information that indicates its source) before analysts can give it to the operational user even at the secret level. While a valid requirement, this level of secrecy has fostered a feeling within the operational community that intelligence has been playing "I've got a secret" and keeping the "good stuff" behind the "green door." The solution to this problem is twofold; first, increasing the number of sensitive compartmented information billets for operations personnel and second, educating everyone on the need to protect intelligence.

The second problem the Air Force faces is how to selectively access, based on the need to know, the multiple classification levels of information within communication and data processing systems. Selective access is done through multilevel security (MLS) systems. MLS systems are a family of devices, features, and components that provide protection for the full spectrum of classified and sensitive information. Currently, a manual interface is required on most systems that need physical operator input to transfer information between systems operating at different security levels. The lack of a common data base that can be accessed at various classification levels has led to duplication of data bases in different systems. Frequently, these data bases are incomplete, inaccurate, or outdated. This lack also prevents the networking of operations/intelligence data bases throughout the tactical air control system.

The lack of an effective MLS system has created several problems that have decreased efficiency and occasionally have led to poor security practices. Only

those individuals with proper security clearances and a validated need-to-know should have access to classified information. In reality, many times the only requirement enforced is the proper security clearance. Need-to-know is determined by the individual.

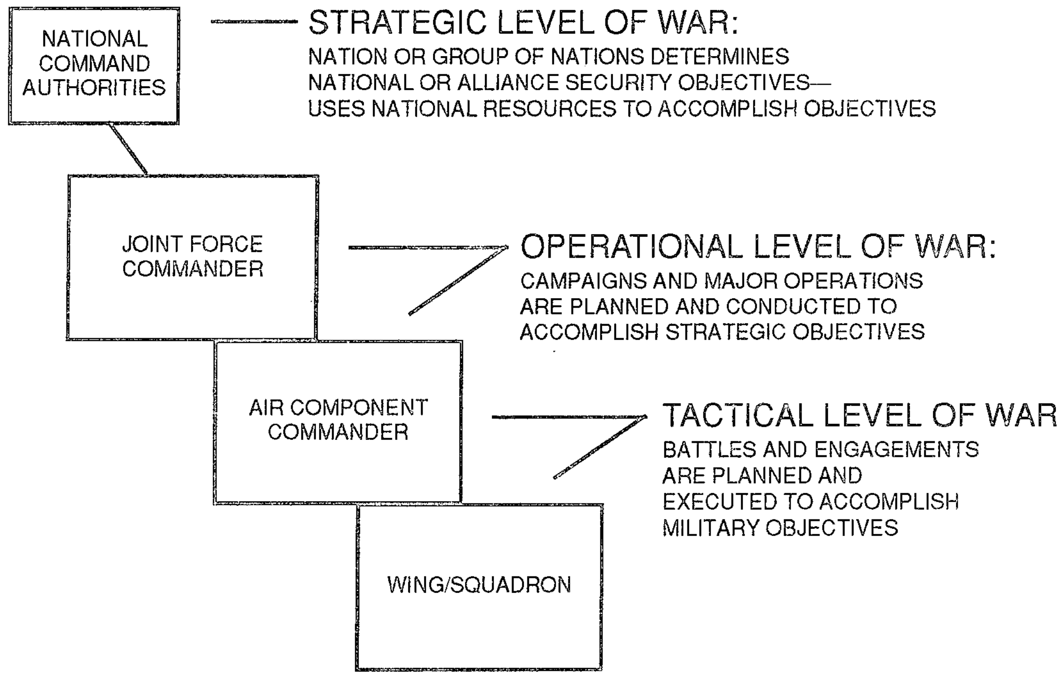
The existing MLS capabilities are too limited in function, numbers, and applicability to support Air Force-wide use. They tend to be one-of-a-kind systems that restrict access unacceptably and increase processing time. The Air Force has a requirement for the major commands, tactical headquarters, and all subordinate and lateral command and control elements to be able to electronically transmit, receive, and process the entire spectrum of operations and intelligence information. This requirement covers all classification levels, compartments, and caveats. Users with the proper clearance and need-to-know must have timely access to information. Users lacking the proper clearance must be denied access to the information.[66]

Procedural Problems

We need to review the way we look at intelligence, reconnaissance, and combat information. "For example, modification of the command and control process and streamlining target identification and reporting procedures may represent a less expensive 'system modification' than purely technical, hardware solutions."[67] One of the largest hindrances to timely intelligence support to the tactical battlefield is the number of "wickets" that intelligence must go through before it reaches the consumer. The present intelligence cycle, developed to support a tactical air control system that evolved from the Korean and Vietnam wars, may not be appropriate to present-day conventional operations. These systems support conventional operations and lack the responsiveness and flexibility to support the entire spectrum of conflict, to include counterinsurgency and counterdrug operations.

During peacetime, the intelligence system emphasizes support to the national command authorities. During wartime or contingencies, the intelligence focus swings to support the operational level of war. During a general or limited conventional conflict (as illustrated by Desert Storm), the joint force commander and the air component commander (ACC) represent the operational level of warfare. This is the level where campaigns and major operations are planned and conducted to accomplish the strategic objectives. The air component level is responsible for conducting air operations within the apportionment and the objectives of the joint force commander.[68] The air component command overlaps into the tactical level of warfare where battles and engagements accomplish military objectives. "The activities at this level require *combat information* in greater detail but with less scope than at the more senior level"[69] (emphasis added). Figure 4 illustrates the levels of warfare and the organizations that fight those levels of war.

On a real-time basis, battle managers at the subordinate levels rather than managers at higher levels may need to have access to these same kinds of



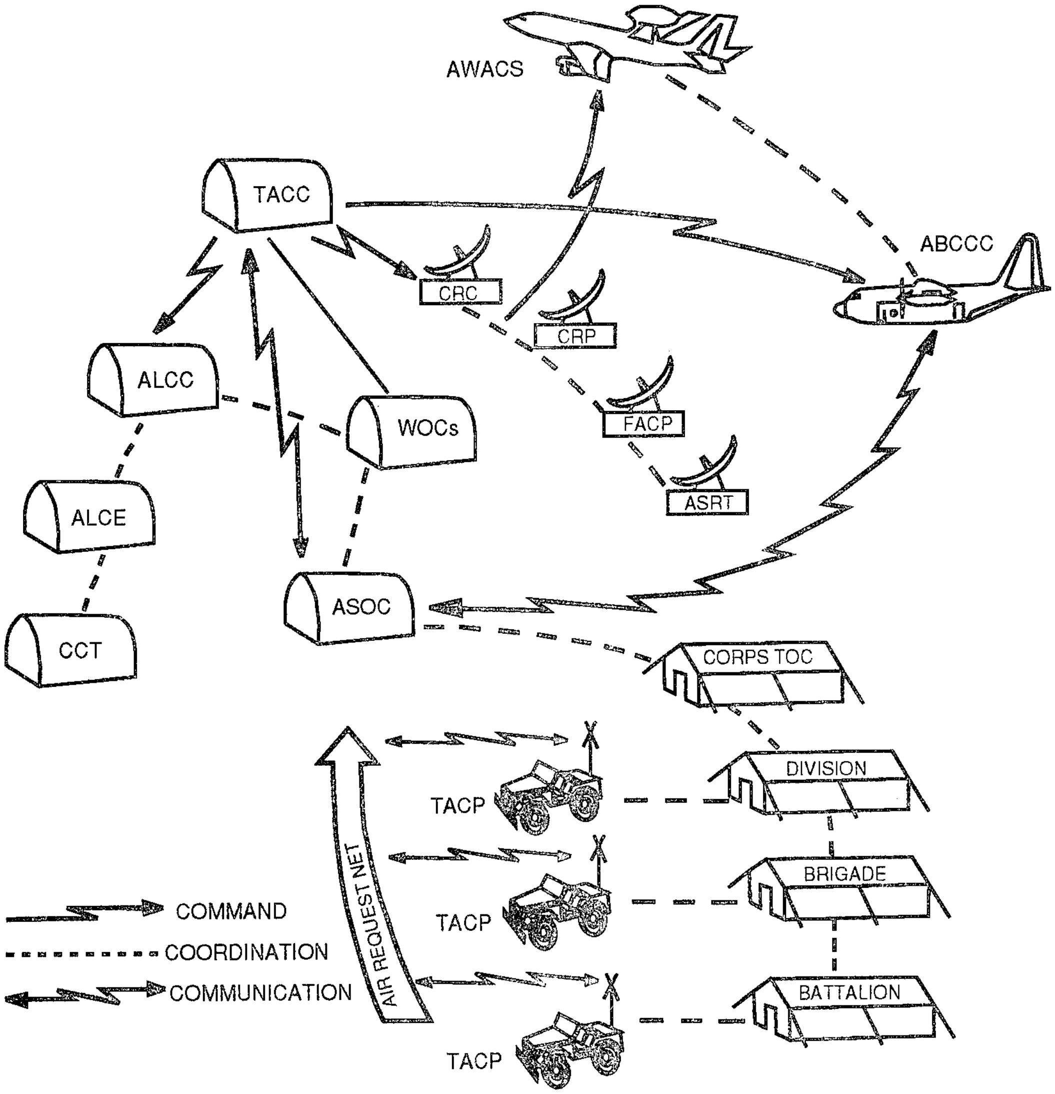
Source: Briefing, Headquarters USAF/IN, subject: Concept for Supporting the Theater Joint Force Air Component Commander, 7 October 1991.

Figure 4. Command Levels of War

information. Centralized control and decentralized execution provide maximum flexibility in the use of air power, but they also concentrate much of the intelligence support and decision making at the top. The decapitation of the tactical air control system by destruction of the tactical air control center or its isolation by means of electronic combat could force subordinate elements of the TACS into the position of having to make decisions without the benefit of the required intelligence/combat information. Communication problems and shortfalls such as those experienced during Desert Storm, which was a relatively benign electronic combat environment, could severely impede getting intelligence and commander's guidance from the TACC to lower levels especially in a general war or a midintensity conventional war. As communications channels are saturated, degraded, or destroyed, commanders at the tactical or execution level will have to make independent decisions.[70] Currently the combat information necessary for such decisions is unavailable to them.

Tactical Air Control System

The tactical air control system plans, directs, and controls air support to combat operations (fig. 5). The joint force commander issues guidance to the air, land, and naval component commanders based on the operational objectives,



Legend:

ABCCC—airborne battlefield command and control center
ALCC—airlift control center
ALCE—airlift control element
ASOC—air support operations center
ASRT—air support radar team
CCT—contingency communications team
CRC—control and reporting center
CRP—control and reporting post
FACP—forward air control post
TACP—tactical air control party
TOC—tactical operations center
WOC—wing operations center

Source: TACR 55-45, *Tactical Air Force Headquarters and the Tactical Air Control Center*, 8 April 1988, 5-5.

Figure 5. Tactical Air Control System Elements

and they in turn develop their plans of support. The joint force air component commander (JFACC) plans, directs, and controls the air forces employed in tactical operations. The ACC is responsible for offensive and defensive tactical air operations, airspace management, and air defense and exercises operational control of all air assets regardless of the nationality or service of origin. Each member of the TACS has a varying requirement for combat information.

The tactical air control center is the air component commander's organization for the planning and execution of the air campaign and is the senior element of the tactical air control system. The TACC is charged with providing battle management for the tactical air forces. Tactical Air Command Regulation (TACR) 55-45, *Tactical Air Force Headquarters and the Tactical Air Control Center,* defines battle management for the TACC as decisions and actions taken in direct response to the activities of enemy forces.[71] It emphasizes that

> essential to this battle management function is the ability of the TACC to accurately perceive and understand the current tactical situation and to make the timely and effective decisions for the employment of tactical air assets. The battle management function is the most critical activity in the TACC and may ultimately decide the success or failure of the theater forces to achieve their assigned objectives.[72]

As discussed in chapter 1, described by FM 100-5, and seen during Desert Storm, modern warfare is rapid and nonlinear. To synchronize the AirLand Battle, "air interdiction must be planned and controlled to be responsive to the dynamics of ground manuever" to exploit fleeting opportunities.[73] The problem may not be the doctrinal argument of where the fire support coordination line should be in relation to the forward line of our own troops, but the practical problem of keeping track of the location of the forward line of troops. Currently, the air tasking order (ATO) cycle is 72 hours with the first 36 devoted to "intelligence gathering and assessment, friendly unit status reporting and tracking, force apportionment planning and approval, and ATO preparation." The second 36 hours are devoted to unit planning and execution of the ATO.[74] The whole concept of a three-day cycle from intelligence gathering to mission execution is obsolete. Technology has drastically cut down the intelligence time requirement. Communications bottlenecks and procedural inadequacies are now the stumbling blocks. Air Force Chief of Staff Merrill A. McPeak stated:

> It is a disgrace that modern air forces are still shackled to a planning and execution cycle that lasts three days. We have hitched our jets to a hot air balloon. Even when this lackluster C^2 system works properly, we are bound to forfeit much of the combat edge we know accrues to airpower because of its flexibility and speed of response.[75]

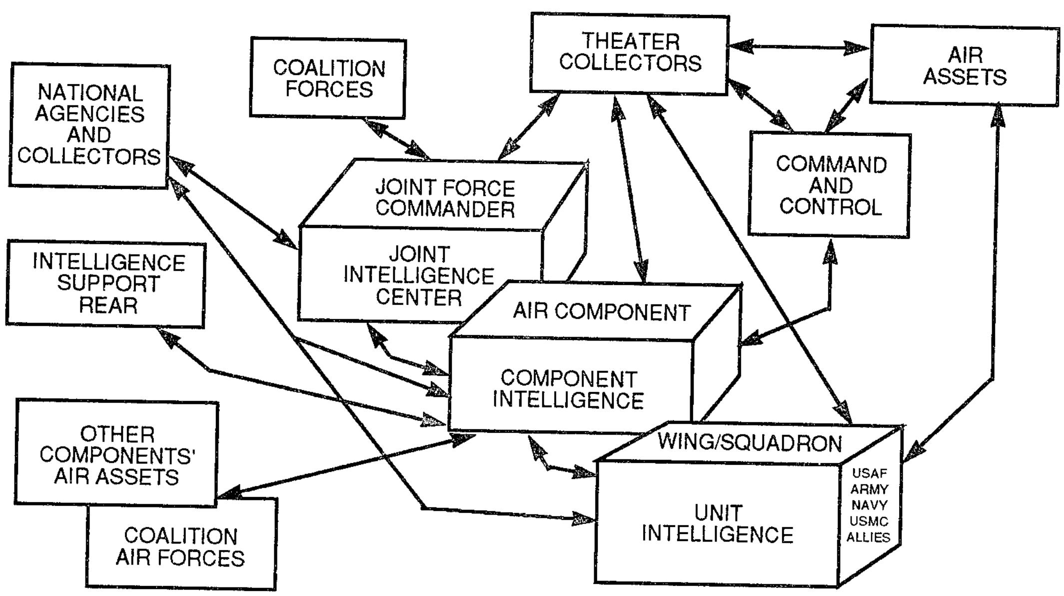
This problem was overcome during Desert Storm by realizing that the air tasking order was to be used for planning purposes by aircrew schedulers, weapons loaders, and maintenance personnel. Up to 30–40 percent of the targets listed in the ATO were back-up targets in the event that no more lucrative targets were discovered on a near-real-time basis.[76]

Tactical Air Control Center Intelligence

Until recently the TACC was the lowest level that received raw unprocessed intelligence information. Now there is the capability at the wing/unit level to receive intelligence from national agencies and collectors, theater collectors, and other assets without necessarily going through a theater intelligence center (fig. 6). The TACC receives intelligence from rear area national intelligence centers, theater collectors, the joint intelligence center, and allied and other service intelligence organizations. The TACC intelligence function supports air campaign planning, air tasking order development, and ATO execution.

According to the Headquarters USAF "Concept for Supporting the Theater Joint Force Air Component Commander," the air component commander's intelligence functions include:

- focused air situation assessment,
- collections requirements management,
- delegated air order of battle/electronic order of battle production,
- air defense analysis/applications,
- target development/planning,
- operational battle damage assessment, and
- unit support for current air operations.[77]



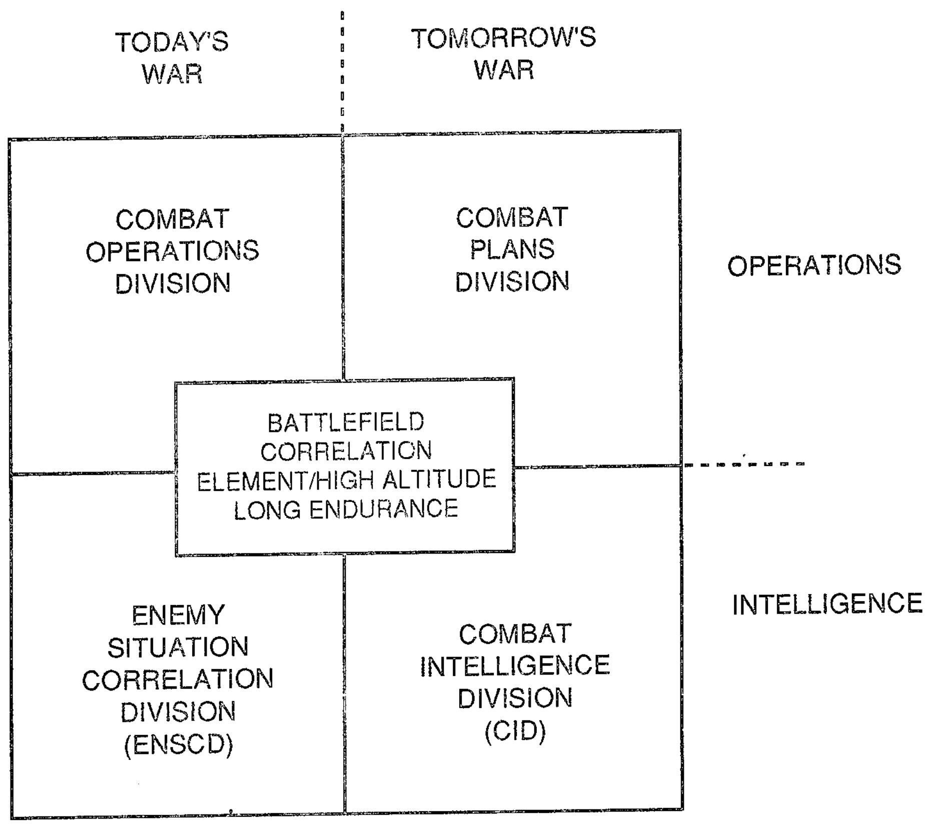
Source: Briefing, Headquarters USAF/IN, subject: Concept for Supporting the Theater Joint Force Air Component Commander, 7 October 1991.

Figure 6. Air Force Intelligence Concept of Operations

Organizationally within the TACC there is a division of responsibility as to planning tomorrow's war and fighting today's war. The combat plans division supported by the combat intelligence division (CID) prepares for tomorrow's war. The combat operations division supported by the enemy situation correlation division (ENSCD) fights today's war. A liaison from the Army called the battlefield correlation element (BCE) interfaces with each division to exchange intelligence and operational data, interpret Army requirements and actions, coordinate air defense and airspace control issues, and request Air Force support for the Army's scheme of maneuver.[78] Liaison elements from the Navy and Marine Corps may be present in the TACC as well (fig. 7).

The TACS has levels subordinate to the TACC to control the defensive counterair and close-air-support missions. The TACC is the operational level that accomplishes coordination and near-real-time targeting for battlefield air interdiction, air interdiction, and tactical air reconnaissance missions.

The combat intelligence division is responsible for collection management, intelligence production, and target intelligence. Within the CID the collection



Source: TACR 55-45, *Tactical Air Force Headquarters and the Tactical Air Control Center*, 8 April 1988, 4-5.

Figure 7. The Tactical Air Control Center

management branch (CMB) is responsible for processing and validating all requests for information from within the TACC and the deployed tactical air forces. If the information is already available, the CMB forwards it to the requestor. If not, the CMB tasks the appropriate tactical collector or forwards the request to a higher echelon to be satisfied by theater- or national-level collectors.[79] Currently the RF-4C and the Senior Scout system are the only dedicated tactical air reconnaissance systems controlled by the ACC. The joint force commander generally delegates control of the TR-1/U-2R and the RC-135 Rivet Joint to the ACC. The F-16R, J-STARS, and reconnaissance UAVs will be ACC reconnaissance assets in the future.[80]

The CID must predict intelligence collection requirements far enough in advance that the necessary information can accompany the air tasking order that goes to the combat consumer up to 36 hours before execution. Unfortunately, the ability to accurately forecast individual targets four to five days into the future under the conditions of modern warfare requires a crystal ball that, to date, is not available to tactical planners.

The intelligence production branch (IPB) is the all-source fusion center, responsible for evaluating the threat, determining the enemy abilities and vulnerabilities, and disseminating the information to the tactical air force agencies and headquarters. These functions are carried out through periodic and spot intelligence reports, intelligence summaries, and briefings for the JFACC and the staff.[81] Since the IPB publishes periodic summaries of the overall situation, it provides the unit level a limited view of the combat situation, but does not provide specifics regarding the target environment.

The target intelligence branch (TIB) is responsible for target development, weapons application, bomb damage assessment, and the attack nomination process used to develop targets for the air tasking order. If the TIB identifies a target that due to its importance or perishability requires attack prior to the next ATO cycle, it forwards that information to the enemy situation correlation division for an immediate attack nomination.[82]

The ENSCD supports the combat operations division by providing intelligence pertinent to current operations. The ENSCD determines immediate threats to friendly forces, issues threat alerts, identifies, and nominates targets for immediate attack and reconnaissance.[83] The ENSCD is the focal point for near-real-time intelligence for much of the sensor data available from J-STARS, Constant Source, and TIBS.

Below the TACC command level within the tactical air control system is the execution and control level. According to TACR 55-45:

> This level translates the general tasks and allocations given by the component level into detailed plans and orders and controls the execution of them in real-time. . . . The activities at this level require combat information in greater detail but with less scope than at more senior levels. Target by target information requirements are not unusual.[84]

The organizations tasked to carry out this execution of air combat operations are the control and reporting center, the air support operations center, and the individual wing operations centers.

Control and Reporting Center

The CRC can be a fixed or mobile radar facility and there may be one or more CRCs within the TACC's overall area of responsibility, depending on the topography, geographic size, and number of forces employed. The CRC directs air defense activities, provides threat warnings to friendly aircraft, provides control or flight following to both offensive and defensive missions, and relays mission changes from the combat operations division of the TACC. The CRC deals primarily with real-time information available from its integral radars, AWACS aircraft, and aircraft track amplification data from near-real-time intelligence sources. Having both sensors and a control function, the CRC is a producer and a consumer of combat information. Dealing with both the ongoing offensive and defensive air battles, the CRC has a tremendous need for faster combat information. By the time the TACC has analyzed the information, the event of interest to the CRC likely will have passed.

Subordinate to the CRC is the control and reporting post. Usually mobile, the CRP provides radar surveillance and control within an assigned subsector and can take over the functions of the CRC if called upon. Its requirement for near-real-time combat information is essentially the same as that of the CRC.[85]

Airborne Elements of the Tactical Air Control System

The airborne elements of the tactical air control system (AETACS) support the ground elements. Included in the AETACS are the airborne warning and control system and the airborne battlefield command and control center. While not yet formally established as part of the AETACS, during Desert Storm the J-STARS performed command and control functions associated with the TACS.

The AWACS can perform as an independent airborne CRC when the CRC is not operational. The AWACS can support the ground-based CRC like a CRP, data-linking its radar picture to the CRC or the TACC. Because of its altitude, the AWACS has significantly better radio and radar coverage than a ground-based radar. The AWACS's air refueling capability and extended endurance provide it with a quick-reaction capability to deploy anywhere in the world on short notice.[86] Like the ground-based radars of the TACS, the AWACS is both a provider and consumer of combat information and intelligence.

The ABCCC also plays a back-up or contingency role, providing radio relay and command and control if the TACC has not been established, has had communications disrupted, or has been destroyed. It can also act as an airborne air support operations center.

As previously described, J-STARS had not completed developmental test and evaluation before its deployment to the Persian Gulf. J-STARS provided

surveillance information to air and land commanders that was used for planning and prosecuting the war. It also performed an ad hoc control function by directing air-to-ground attack sorties against perishable targets. There was considerable discussion as to whether the J-STARS was primarily a targeting or intelligence platform, and serious arguments developed when it was necessary to emphasize one mission over the other.[87]

Air Support Operations Center

The element below the TACC for the decentralized execution of close air support is the air support operations center (ASOC). The ASOC is responsible for planning, coordinating, and directing tactical air support for the ground forces at the corps level. This support includes close air support, tactical air reconnaissance, and tactical airlift. The tie between the corps and the TACC is essential to providing the congruent view of the battlefield that General McPeak describes and providing unity of effort.

Normally collocated with the corps command post, the ASOC's senior air liaison officer employs the distributed air assets allocated to the corps in the air tasking order. The liaison advises the corps command post of the air situation, assists them in planning the use of tactical air assets, and forwards Army requests through the Air Force Air Request Net (AFARN).[88] As previously discussed, the doctrine of maneuver warfare has blurred the distinctions between CAS and interdiction. The current intelligence cycle to support interdiction is completely inadequate to support independent thrusts deep in the enemy's rear area. Interdiction today needs the same type of near-real-time information that close air support has needed.

Wing and Squadron Support

The individual wing operations centers are the third subordinate element within the tactical air control system. These centers serve as the command posts or operations centers for each of the flying units. The wing/squadron level of warfare is the purely tactical level of war where "battles and engagements are planned and executed to accomplish military objectives."[89] Intelligence functions at the wing and squadron include providing situation awareness, air defense threat applications, weapons and tactics support, target materials support, aircrew briefing and debriefing, and mission effectiveness evaluation. Timeliness is the biggest problem facing unit-level intelligence personnel. Situation awareness information is often limited to the periodic intelligence summaries provided by the tactical air control center. Some units, depending on their mission, have access to Constant Source and TIBS information to enhance situational awareness and provide a near-real-time update to the air defenses.

The mission results and unit-derived battle damage assessments are accomplished within the unit upon landing and are forwarded through normal communications channels to the tactical air control center. Although combat cameras on aircraft have a relatively long history, the intelligence system has placed little reliance on the imagery, ELINT, and pilot reports forwarded to the TACC from combat units, preferring to rely on dedicated intelligence systems to confirm battle damage. Videotape from aircraft weapon systems proved a valuable source of battle damage assessment (BDA) during Desert Storm, but an efficient way of incorporating it into the intelligence cycle was unavailable.[90]

The advent of composite wings presents numerous challenges to intelligence personnel at the unit level. The intelligence requirements of a unit with a close air support mission are very different from that of a unit with a suppression of enemy air defenses (SEAD) or counterair mission. Moreover, intelligence shops at the wing level are not manned or trained to perform the planning and targeteering that will be necessary to carry out mission-type orders. While this type of air tasking order relieves the TACC of much of the operational planning, intelligence shops will have to increase their coordination with the unit level regarding data base information, collection requirements, and reconnaissance and surveillance tasking. When the wing accomplishes target selection and attack timing, wing intelligence personnel must closely coordinate with the TACC to get targeting imagery, enemy orders of battle, and air defense information. Unit assets must accomplish BDA or coordinate with the TACC to task tactical or national systems to assess the damage. To speed up the decision cycle, it may be necessary to launch aircraft without the most current, detailed information. In such cases, the crew will have to rely on such airborne surveillance systems as Rivet Joint or J-STARS to update information en route to the target.

Decentralized execution of the battle could hinder synchronized efforts to take advantage of available SEAD and air support. Even with the WOC selecting targets and timing, the wing must coordinate with the tactical air control system, particularly the airborne elements. The wing may have to change the way it tasks reconnaissance assets in support of air commanders and use a system similar to the method the Army uses to provide immediate or preplanned CAS sorties to the corps commander. The wing would allocate reconnaissance assets to mission commanders on a piecemeal basis or have reconnaissance assets on strip alert. Either method is a dangerous erosion of centralized control of air power assets. The greatest disadvantage to this system is the difficulty in consolidating collection requests and optimizing the use of already overtasked tactical reconnaissance assets.

Headquarters Air Force intelligence describes intelligence applications today as "mostly grease pencil operations" with "limited, non-standard automation systems" and "no automated interface with mission planning systems."[91] The 72-hour air tasking order cycle allowed more time for evaluation and distribution of intelligence to the tactical units. "The problem has always been that the long-range sensor was several layers of command and

control from the shooter."[92] The exception to this rule has been counterbattery radars for the field artillery and air defense search and track radars. Both of these applications are defensive in nature, but the sensor-to-shooter relationship is worthy of investigation as it relates to offensive operations. With the development of collection systems such as J-STARS, the Advanced Tactical Air Reconnaissance System, and TIBS, as well as already fielded systems such as AWACS, there is a need to reexamine the roles and missions of various elements of the tactical air control system to determine what role, if any, collectors such as J-STARS and Rivet Joint should have in tactical battle management and threat warning. The serial reconnaissance cycle that requires ground processing of intelligence imparts unacceptable delays in providing near-real-time combat information.

The Cockpit

Aircrews and individuals are the final level of consumers of intelligence and combat information. The Red Baron studies of air-to-air victories in Southeast Asia determined that 82 percent of all air-to-air victories were attributable to surprise attack.[93] Other studies of surface-to-air threats have produced similar results. Integration of stealth technologies and increased use of passive detection systems and off-board operations and intelligence information could be significant in giving the USAF the first shot. Until recently, after take-off the only intelligence or combat information an aircraft received was from such onboard sensors as radars, forward looking infrared systems, and radar warning receivers and from radio calls from controlling agencies of the TACS.

During the summer of 1991, the USAF Scientific Advisory Board looked at the possibility of providing other off-board sensor support. It proposed that the survivability of aircraft could be enhanced by providing the location and identification of surface and airborne threats and their supporting sensors. The Air Warfare Center at Eglin AFB, Florida, had already become interested in providing off-board support to aircraft based on a proposal from General Dynamics. Initially conceived as a method of providing targeting information to SEAD aircraft, the potential of the Fastball program in other mission areas soon became apparent. The demise of special mission aircraft and the technical and financial risk of new aircraft systems made the employment of off-board sensors to support tactical operations appealing.

> Specifically, the use of off board and on board sensors and processors in an integrated system to provide threat warning, identification, and targeting support across the spectrum of tactical missions is proposed as a method to alleviate the burden for dedicated special mission systems and to supplement on board resources in satisfying tactical mission requirement.[94]

Fighter and bomber aircraft need target location updates for mobile and relocatable targets (e.g., mobile command posts, surface-to-surface missiles,

armor, and motorized infantry units).[95] Cargo aircraft would benefit from up-to-the-minute information on drop zones and en route threats. All missions would benefit from increased situational awareness with regards to friendly and hostile forces before coming into range of enemy weapons. New "launch and leave" weapons have capabilities to strike targets well beyond the line of sight of the launching aircraft, ship, or missile site. These launches could greatly benefit from the ability to provide target updates to their weapons once they are en route. A primary requirement of any system providing combat information to the cockpit must be that it does not add to the aircrew's work load. An F-15 pilot, for example, already receives data from 75 displays and warning indicators.[96]

Conclusion

Air Force reconnaissance and intelligence capabilities are a result of trends that have developed over several years (fig. 8). Air Force reconnaissance tends to be strategic, using a limited number of platforms that generally are not designed to work with other Air Force or joint service systems. The various intelligence disciplines are stove piped with tight functional supervision within each discipline. Current USAF reconnaissance and intelligence systems do not adequately support joint service requirements and do not take advantage of the numerous systems fielded by the other services.

The intelligence cycle of the past is outdated and only supports conventional operations in a somewhat static environment. The cycle is not in keeping with the AirLand Battle/AirLand Operations doctrine that is the basis of current planning for conventional operations. The intelligence cycle is not responsive enough to support fast-breaking contingency operations or low-intensity counterinsurgency operations. The intelligence environment including the process, products, and customers has changed.[97] What is needed is a centrally controlled, near-real-time combat information system that is exercised frequently and that provides sensor-to-shooter information in a timely, accurate, and secure manner. This conclusion is a lesson evident throughout history and corroborated in the Persian Gulf in 1991.

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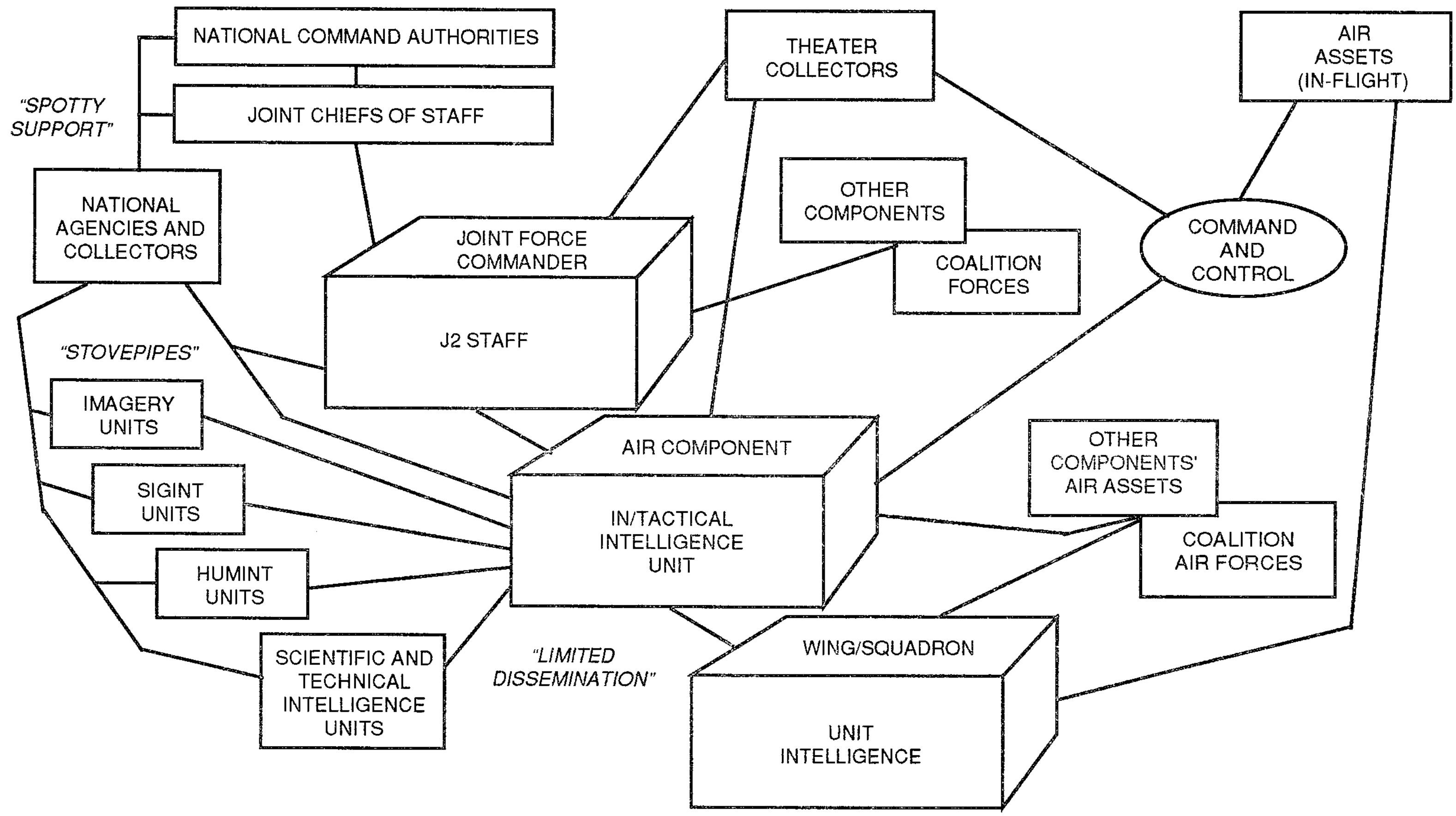

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Chapter 5

Recommendations for a Combat Information System

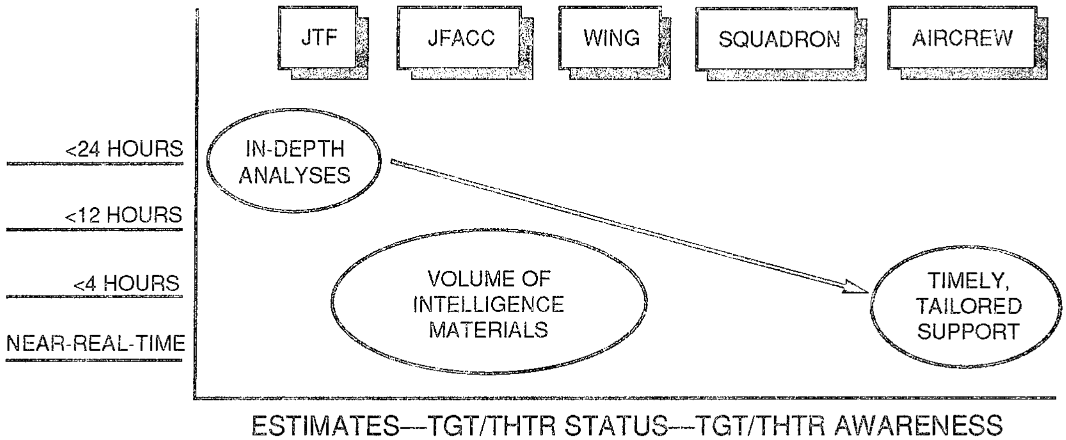
What is needed is a single invulnerable system that sees the entire battlefield 24 hours a day under all weather and light conditions, filters the information according to individual commander's needs and instantly transmits all pertinent information directly to the user just as events are occurring on the battlefield.

—Lt Gen Charles A. Gabriel

When General Gabriel summarized his ideal reconnaissance/surveillance system in 1979, technology had not reached a state where we could even approximate this kind of a system. What is needed today is a combat information system that combines near-real-time operations and intelligence data and provides the information simultaneously to several echelons of command and to a variety of tactical users in all services (fig. 9). Different elements of the tactical air control system control the air power missions of counterair, air interdiction, close air support, special operations, airlift, and maritime support operations. The specialized tasks of aerial refueling and air rescue and recovery have similar requirements. Each level of command and each mission has individual requirements for near-real-time combat information support. At the joint task force level, the commander needs in-depth analysis of the theater situation. Aircrews need timely, tailored combat information.

Recently the Air Force has focused much attention on providing intelligence, threat warning, and combat information to combat aircraft. Noncombat aircraft, however, may have an equal requirement for this information. Airlift aircraft dropped paratroopers on the stronghold of Rio Hato and Tocumen International Airport in the first hours of the invasion of Panama.[1] During Desert Shield "the first aircraft to land in Saudi Arabia . . . was a C-141 carrying an airlift control team to handle the vanguard of US air and ground combat forces."[2] For unarmed airlift and air refueling aircraft, a combat information system is important because these aircraft generally do not have onboard warning or self-protection systems such as radar warning receivers, chaff, or flares. Similarly, the Civil Reserve Air Fleet, which delivered 64 percent of the troops and 28 percent of the cargo to Desert Shield/Desert Storm has no onboard warning or self-protection systems.[3]

The threat environment US forces will encounter in future conflicts likely will be characterized by increased threat density and lethality, complex orders of battle, smaller and more mobile targets, all-weather 24-hour operations, a numerically superior enemy, and minimal fixed infrastructure. US forces will



Legend:
JFACC—joint force air component commander
JTF—joint task force
THTR—theater
TGT—target

Source: Briefing for the Air Force Council, subject: Intelligence Support for Theater Air Operations in the 1990's, 4 December 1991 (with 16 December 1991 update).

Figure 9. Command and Control Requirements/Intelligence Functions

take into this conflict an arsenal of precision weapons, high-performance weapons delivery systems capable of performing under all weather and light conditions, and unprecedented communication and intelligence capabilities that will provide vast amounts of near-real-time information to the decision makers.

The Air Force of the foreseeable future will be a more streamlined force than that of the 1970s or 1980s. From a goal of 40 fighter wings, we are cutting to approximately 23 wings. Special purpose aircraft, such as the F-4G Wild Weasel and the dedicated RF-4C, will no longer be sustainable within reduced budgets. Aircraft will have to be multipurpose, capable of swinging from air-to-air missions to air-to-ground missions as the tactical situation dictates. With limited numbers of weapons platforms available, commanders will need faster, more precise intelligence so they can become more selective about which key targets to destroy. The command and control system must be capable of rapidly reacting to changes in the situation and of shifting emphasis to the most urgent needs, targeting or retargeting aircraft in flight as necessary.

Today we have the capability to develop and deploy a system that integrates many of the key features General Gabriel envisioned. The most important function of tactical reconnaissance will be integration of space-based systems, airborne stand-off surveillance platforms, unmanned aerial vehicles, and manned penetrating aircraft to improve the responsiveness and quality of information available.[4]

The Air Force Studies Board summer study of 1986 concluded that tactical battle management could be significantly improved using current technology

and that an approach using both users and developers is needed. The board felt that evolutionary improvement with rapid prototyping and fielding is critical to maintaining our technological edge in tactical battle management.[5] The Committee on Tactical Battle Management of the board found that a major barrier to effective planning and execution is the current inability to maintain and distribute combat information to various echelons in a timely manner. Present theater-specific command and control (C^2) systems task aircraft to fly missions, but these architectures lack the ability to integrate the information needed to control the tasking process.[6] The board concluded that C^2 architectures need an automated fusion capability to fully exploit the greater volumes of data that will become available.[7] TACM 2-1, *Aerospace Operational Doctrine: Tactical Air Operations,* section 4-3, "Reconnaissance, Surveillance, and Warning," lists the four broad tactical applications of reconnaissance and surveillance as prediction of enemy intent, threat warning, reporting of enemy status, and targeting.[8] Brig Gen Kenneth F. Minihan, Headquarters USAF director of intelligence systems support, delineates the war-fighting support responsibilities of intelligence as situational awareness, threat assessment, and targeting materials.[9] The goal of reconnaissance and intelligence is to prevent surprise and to support getting bombs on target. The challenge for the 1990s is to get timely, accurate, tailored combat information to the person who needs it.

A 1988 Competitive Strategies–European study showed that command, control, communications, and intelligence (C^3I) systems are the "essential foundation for theater-wide targeting."[10] The Air Force White Paper, *Air Force Performance in Desert Storm,* stated that the effort to merge new command and control capabilities "will define the modern battlefield of the future."[11] A 1986 report, *Technologies for NATO's Follow-On Forces Attack Concept,* concluded that the technologies required, especially within the areas of reconnaissance, surveillance, and data handling, were relatively mature and systems could be fielded by 1996.[12]

The sensors exist to detect the enemy at long range and to report to key intelligence centers in near real time, and the munitions to destroy these targets are either operational or are being fielded. What is left to complete General Gabriel's vision is to improve the command, control, and communications system so that it will allow for the rapid targeting and intelligence support that we are now capable of providing. The goal of tactical battle management is to make the process from planning to execution as sophisticated as the weapons it supports by increasing the automation and integration of C^3I systems. "Two elements are missing in providing this capability to commanders: a sensor tasking mechanism and sensor fusion and internetting."[13] Procedures and communication systems are needed to allow real-time collection management. The combat information system of the future must "link sensors with decision-makers and facilitate the interchange of intelligence and combat information. Such automation can permit commanders to operate within the time span of the opponent's decision cycles."[14] The introduction of the

AWACS, J-STARS, and Rivet Joint into the command, control, communications, and intelligence system started this process.

We must also review the command and control organizations and procedures that we use to employ air power. The serial process of decision making must be decentralized and a parallel system established to provide combat information to multiple echelons. We must also take care that instantaneous worldwide communication does not concentrate decision making in the Pentagon or White House. The day-to-day selection of targets by President Lyndon Johnson during the Vietnam War and the personal involvement of President Jimmy Carter during the decision to abort the Desert One mission exemplify the dangers of overcentralizing decision making merely because communication systems permit. Tactical decision making must remain with the lowest level having sufficient information to do it. A combat information system that provides operations and intelligence information to multiple echelons will allow such decision making.

The Combat Information System

The command and control cycle for any military force includes three components: see—decide—act. The modern sensor capabilities of the US military provide unprecedented ability to see vast areas of the battlefield in considerable detail. Precision munitions allow us to strike at these areas from a great distance and with tremendous accuracy. Improvements in the decide portion of the cycle (including command, control, and communications) offer the greatest opportunity for ensuring that we are able to operate within the decision cycle of the enemy and to maintain the initiative and flexibility required.

Figure 10 shows the general sequence of events from the time an intelligence sensor observes an event until the time control elements report the event to the shooter. The sensor detects the event, transmits the information to a processing center, or after landing sends such things as the film or tape to a processing center that converts the information into a usable form. Next an intelligence center evaluates and combines the new data with other data, then sends this combination to an operations command center. There a decision maker uses it to direct the control elements or the shooters to take action. The time from the occurrence or observation of an event to the consumer actually receiving the information could range from several minutes to several hours or even days.

Technology in the area of sensors, data processing, and communications has dramatically improved. The Air Force C^3I structure, procedures, and a mind-set of "intelligence" versus "targeting information" have prevented us from fully taking advantage of technological capabilities. Most intelligence systems process and disseminate information through a series of discontinuous communication networks that involve considerable manual interface and do not provide rapid targeting information. AWACS and J-STARS already use some

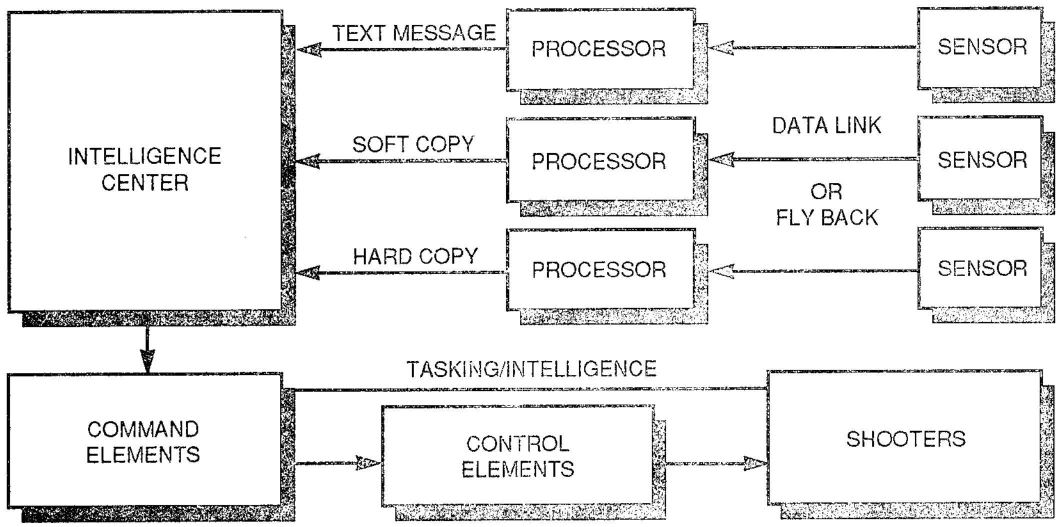


Figure 10. Information Flow in the Reconnaissance Cycle

near-real-time combat information to target enemy forces, but there are no established procedures and architectures capable of providing this support.[15] The Air Force must update the formal roles and missions of these aircraft and develop tactics and procedures to be documented in an aircraft specific volume of multicommand manual 3-1, *Mission Employment Tactics,* so that aircrews, C^2 staffs, and decision makers can become familiar with the capabilities of these assets.

Figure 11 shows the flow of operations and intelligence information in the proposed combat information system. Each of the areas is described below, starting with the near-real-time collection management or sensor management function.

A near-real-time sensor tasking function would be created that would overlap the combat operations division and the enemy situation correlation division of the tactical air control center (TACC). The near-real-time collection manager would act similarly to the fighter duty officers in combat operations, monitoring the current tactical situation and making adjustments (fig. 12). Based on inputs from the air tasking order, established essential elements of information, reconnaissance tasking requests from the TACC, and joint service requirements from the service liaison elements, the real-time collection manager would revise the taskings of sensors—passing requirements either directly to the sensor or through the appropriate ground station or direct support unit. The manager would monitor the air tasking order and the friendly ground situation and coordinate with collectors to provide timely information for last-minute target/threat updates or near-real-time battle damage assessment to the shooters.

Such sensors as Rivet Joint, J-STARS, and the Contingency Airborne Reconnaissance System (CARS) could confirm that a previously assigned target is still lucrative, refine location and threat information, and broadcast correlated

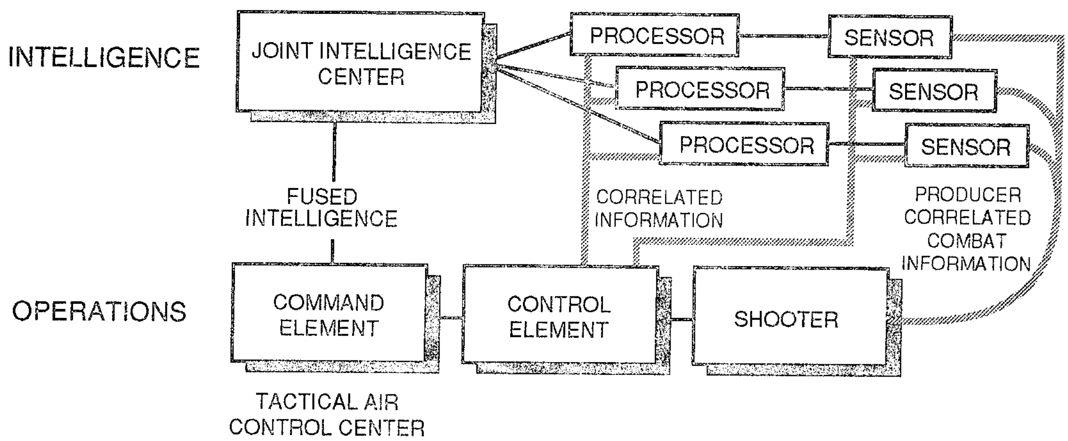


Figure 11. Information Flow in the Combat Information System

combat information over the combat information net to en route strike aircraft. Operators on board aircraft or controlling sensors from the ground will compare information they receive in near real time and send it simultaneously to the control elements and to the tactical war fighters (fig. 13). The individual collectors will distribute a correlation of the information as it is obtained. Collectors will report the information they have gathered only if no one else has reported it, or if they can add to a report someone else has previously made. Collectors will not report redundant information except as updates.

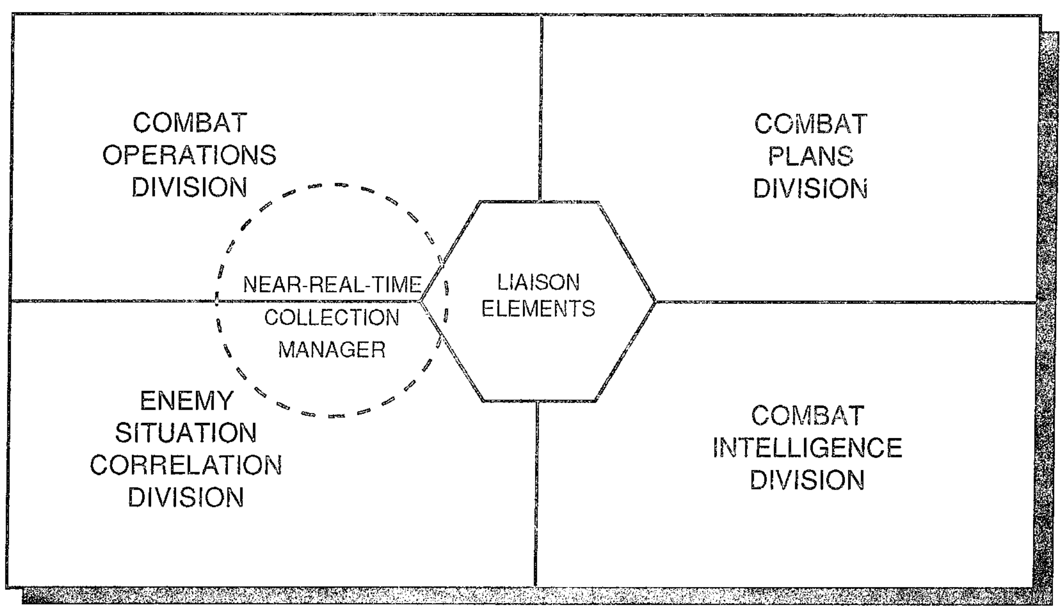


Figure 12. The Tactical Air Control Center

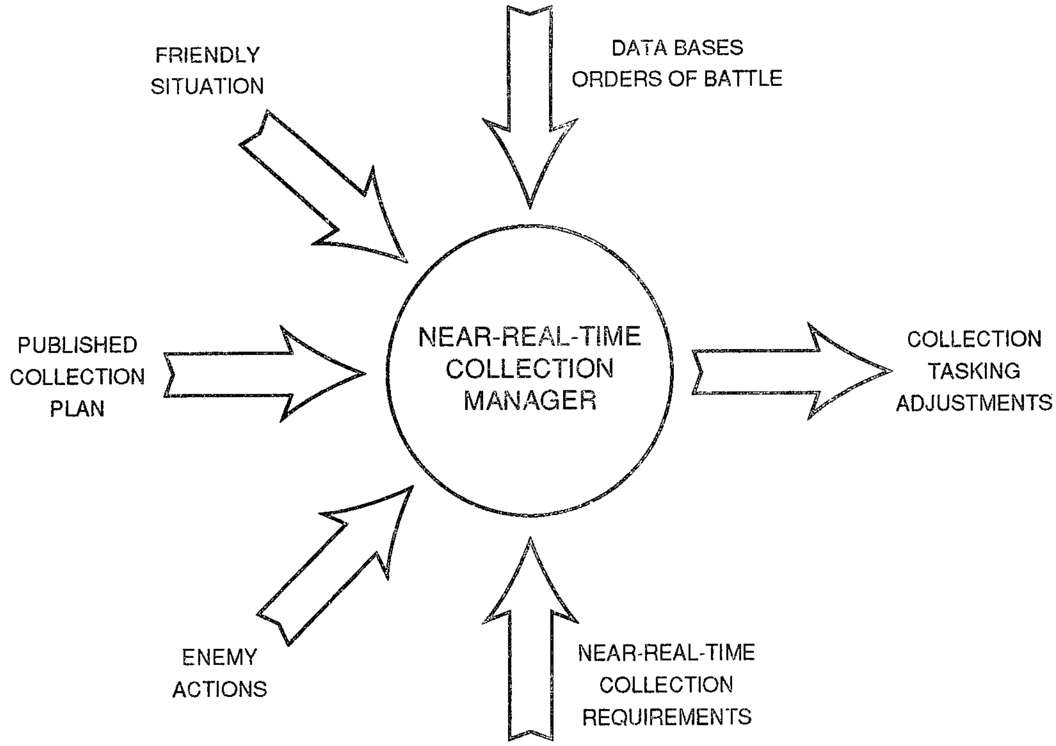


Figure 13. The Near-Real-Time Collection Manager

Simultaneously, collectors pass the information to the ground processing station (e.g., the J-STARS ground service module, the direct support unit, or the U-2R ground station) where normal processing and correlation takes place. Ground processors will pass correlated information to a joint intelligence center that fuses it with information from other sensors to provide a fused intelligence product to the air, land, and naval component command elements (fig. 14). The ground processing centers also pass the correlated information to the various control elements responsible for the real-time tactical battle management of current operations. These control elements should be from all services and could be the control and reporting centers, air support operations centers, corps tactical operations centers, or the combat operations division and enemy situation correlation division within the TACC.

The end users are the shooters. They are the mission coordinators or war fighters at the unit level. The mission coordinators and war fighters receive selected information based on filters they have defined with regard to type of information, geographic area, and timeliness. Shooters use the information to refine targeting information and increase situational awareness. Mission coordinators pass the appropriate information to members of their packages and pass battle damage assessments back to command and control elements (fig. 15).

From the operations side, identification and positional information on land and airborne forces would be integrated from radar, identification friend or foe

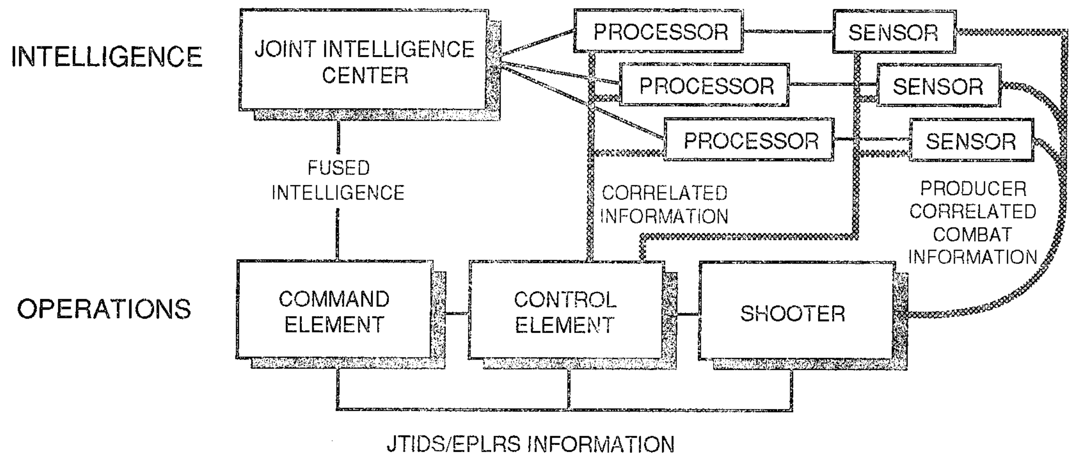


Figure 14. Producer Correlated Information

systems, and the Army and Marines Enhanced Position Location Reporting System (EPLRS) inputs. This information would provide a graphic display of the friendly situation to allow an assessment of the opposing forces and better allow commanders and analysts to determine the enemy's intent.

A key element of discriminating between friend and enemy in a fast-moving war is accurate knowledge of the location of friendly forces. To keep track of friendly forces, the Army and Marines have begun using the Position Location Reporting System (PLRS) or the enhanced PLRS (EPLRS). The 26-pound EPLRS can be carried on troops' backs, or in trucks, tanks, and helicopters to provide data communications and identification, position, and navigation information to units on the ground or in the air.[16] PLRS provided rapid unit position updates to deployed units and their command centers during Desert Storm, allowing commanders to see graphically on a computer screen the location of the lead units in the thrust against Iraqi forces in Kuwait.[17]

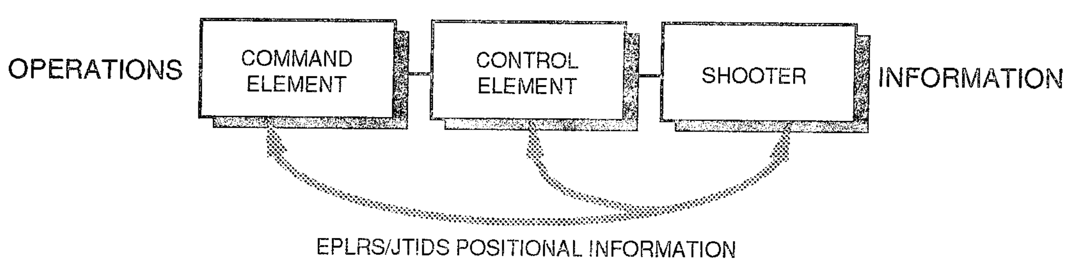


Figure 15. Operations Information Flow

EPLRS provides several key services to the commander. First, it eliminates more than 50 percent of the radio calls over the combat radio nets to request or pass positional information.[18] Second, it provides positive identification and location information to within 15 meters to deconflict fire support and reduce fratricide. Deployed units can positively identify EPLRS-equipped units within their vicinity. Commanders can program such things as free fire zones, mine fields, enemy positions and rendezvous points into the system as well as movement orders for friendly units.[19]

The Army and Marine Enhanced Position Location Reporting System is becoming the primary ground radio for the distribution of digital data on the tactical battlefield. EPLRS employs a time-division, multiple-access architecture to provide positional location, other friendly locations, enemy or hazard locations, and command and control messages. Incorporating capabilities of the EPLRS into the tactical air control system will provide those elements of the TACS, such as the air support operations center and TACC responsible for conducting operations in proximity to friendly forces, operations information essential to protecting friendly forces. Through a combat information system, the TACC or ASOC could pass the attack aircrews target updates and threat warnings on a near-real-time basis providing maximum flexibility and situational awareness. Attacking aircraft could maintain radio silence and minimize the use of onboard sensors to reduce the enemy's passive detection possibilities.

Command, Control, Communications, and Intelligence Organizations

The tactical air control system is the command, control, communications, and intelligence architecture for air power. With the explosion in the amount of intelligence and combat information available, dissemination to the user needs to be decentralized. The TACC does not require the amount and detail of information needed by the tactical consumer. Timeliness requirements of the tactical users preclude processing information at a central intelligence facility before distribution. In an effort to reform our antiquated system, the Air Force has established a tactical battle management working group with objectives of reducing the time from decision making to application of firepower and automating and integrating C^3I systems into all levels of command.[20] This initiative hopes to reduce the proliferation of stand-alone command and control systems. The Air Force should have one system throughout the theater of operations because it plans and executes air power on a theater-wide basis. The proposed combat information system fits into this concept of integrating current and future systems into a joint, interoperable system.

The first step toward integrating operations and intelligence is formalizing the introduction of Rivet Joint and J-STARS into the command and control system. Integrating more intelligence sensors into the system would bring the

collectors closer to the war fighter in terms of timeliness. Air Force Chief of Staff General McPeak stated, "The least payoff is where there is a big separation between the intelligence sensor and the guy who can do something about the situation that is sensed."[21] The system also needs a node control or real-time collection management function to coordinate and control collection and dissemination of surveillance information in support of ongoing operations. Possession of near-real-time intelligence systems does not diminish the requirement for traditional intelligence analysis data bases. On the contrary, complete order of battle information is essential to the rapid correlation of new information. The Air Force must revamp the tactical air control system to take advantage of this new capability and increase the synchronization and synergism of joint operations.

Tactical Air Control Center—Combat Operations

In the mid-1980s the Air Force envisioned a new control element under the TACC called the ground attack control center (GACC). The GACC would receive near-real-time intelligence/combat information from a variety of sensors and determine which targets to attack within the constraints of guidance received from the TACC. The GACC would "pair assigned air assets against these targets, order the execution of the missions, and provide the mission aircraft with target update information."[22] The GACC would have authority for controlling offensive operations within a specific geographic area, just as a control and reporting center is responsible for defensive air operations and forward air controllers are responsible for close air support. The GACC would have assets provided by the air tasking order, all-source correlated intelligence from the enemy situation correlation division of the combat operations intelligence division, and weapons commit authority from the air component commander. The GACC would provide sufficient combat information to the tasked aircraft to complete their mission or would hand off final targeting responsibility to a sensor for final control.[23]

When the GACC fell victim to fiscal realities, the mission of controlling the near-real-time battlefield air interdiction (BAI) and air interdiction (AI) missions reverted to the combat operations division within the TACC. When the tactical air control system was designed, the combat operations division was to coordinate and monitor BAI and AI activities, but there was no capability at that time to watch the battle in real time and task assets accordingly. The enemy situation correlation division is the focal point for near-real-time intelligence at the TACC. The information it needs on a near-real-time basis are tip-offs that enemy movements or attacks are under way, identification of promising kill zones, the latest location and status of enemy air defenses, and indicators that can help focus real-time sensors on potential enemy activity.[24] To carry out the missions envisioned as the responsibilities of the GACC, the combat operations division must have the same assets, especially the access to near-real-time combat information.

Air Support Operations Center

This near-real-time combat information provided to the execution level is essential to the synchronization and deconfliction of fires between the Army and Air Force. BAI, suppression of enemy air defenses, and command, control, and communications countermeasures (C^3CM) forces require near-real-time intelligence and targeting to take full advantage of their flexibility and capability. The ASOC has a close working relationship with the Army at the corps level and provides close air support (CAS), tactical reconnaissance, and tactical airlift support. The distinctions between close air support and battlefield air interdiction are becoming increasingly cloudy, and the ASOC is becoming responsible for fighting more of the ground war while the control and reporting center is responsible for the air war. The near-real-time information requirements for CAS and BAI include the precise location, configuration, and composition of the target, the status of the target including battle damage assessment from previous attacks, and the location of air defenses.[25] As Lt Col Price T. Bingham, former chief of the Airpower Doctrine Division of the Airpower Research Institute wrote:

> Air interdiction must be planned and controlled to be responsive to the dynamics of ground maneuver. Thus, campaign success is likely to depend on the ability to closely integrate the development of ground maneuver and air interdiction plans, as well as on quickly adjusting the execution of both to exploit fleeting opportunities.[26]

The air support operations centers execute the close-air-support mission. Working closely with the Army and typically collocated with a corps tactical operations center, they work closely with both Army and Air Force operations and intelligence personnel and have a critical need for the type of information the combat information system could provide. Nowhere is the need for timely and accurate information greater. The rapid movement of the forward line of own troops (FLOT) creates unprecedented potential for fratricide. Experience in Desert Storm showed a tenfold increase in the incidents of fratricide as the speed of maneuver and lethality of firepower, both on the ground and in the air, outpaced the capabilities of operations and intelligence systems to identify forward troops.

Corps Tactical Operations Center

The corps tactical operations center (CTOC) is the Army C^2 node primarily concerned with the delay, disruption, and destruction of enemy second echelon forces 70 to 150 kilometers beyond the FLOT. It is the primary Army element concerned with fighting the deep battle of the AirLand Battle doctrine and is the location of the Army's J-STARS ground station. As described in chapter 4, Army intelligence and electronic warfare (IEW) units do not have assets capable of supplying all the intelligence and combat information needs of the corps to fight the deep battle, and the Army relies on the Air Force for much of its near-real-time support to the deep battle. What the CTOC can provide to the combat information system is detailed information

on friendly locations from the EPLRS and the intelligence information available from the corps-level IEW units.

Units below the corps level could also make use of the combat information system. During Desert Storm, a Marine commander watched real-time video from UAVs as he drove toward Kuwait City. Thus he monitored Iraqi reactions to his movements and was able to adjust his offensive accordingly. Army AH-64 Apache pilots watched real-time video from UAVs on reconnaissance missions to familiarize themselves with the terrain and to select potential targets immediately before takeoff.[27] The addition of other intelligence disciplines and collectors would enhance overall situational awareness and provide a robust, redundant supply of sensor information.

Control and Reporting Center

The control and reporting center (CRC) executes the defensive counterair mission and, to a lesser extent, supports the suppression of enemy air defenses (SEAD), close air support, offensive counterair, air interdiction, special operations, and maritime operations missions. Providing near-real-time intelligence to the CRC would allow battle managers to identify threats earlier, with greater accuracy, and to optimize countermeasures by putting the right aircraft against a particular threat.

The near-real-time combat information requirements for air defense operations include early tip-offs that an enemy attack is forming, the location of approach routes or penetration corridors to be used, and the types of aircraft involved.[28] By having the type of enemy aircraft, the size of the enemy strike package, and potential target areas displayed by the combat information system, controllers would be better able to pair defensive counterair assets against the most dangerous threat and to optimize their mix of air- and ground-based air defenses. Earlier identification of enemy strikes would allow more efficient pairing of defensive counterair aircraft, allowing aircraft to stay with a tanker or on strip alert longer, thereby conserving fuel needed for the engagement. Foreknowledge of the type of enemy aircraft or strike package would allow the flight lead to tailor tactics to the threat.

Providing precise parametric and location information to defense suppression aircraft would allow them to terrain mask longer without exposing themselves to danger or tipping off enemy defenses to their presence or location. Near-real-time combat information updates to offensive counterair, air interdiction, close air support, and special operations missions could improve situational awareness by updating targeting, threat, and friendly position information. In rapid maneuver warfare, the forward position of friendly forces can change significantly between a premission briefing and the time on target. Conversely, this near-real-time combat information system would provide updates to friendly ground air defense about the passage of friendly aircraft over the forward edge of the battle area and areas deep in the enemy rear area.

The Shooter

The final level to be supported by the combat information system is the shooter—the war fighter who has weapons launch capability either on the ground or in the air or who carries personnel and supplies into combat zones. On the ground a wide variety of elements would benefit from the system. The first of these is the air defense mission. The Joint Air Defense Operations/Joint Engagement Zone (JADO/JEZ) Program is currently engaged in determining better ways to distinguish between friendly and hostile aircraft and to allow ground and airborne air defense assets to operate in the same airspace. The program is using a combination of off-board intelligence systems, noncooperative target recognition systems, and active aircraft sensors to develop a means to identify enemy aircraft and prevent fratricide.[29] The combat information system would provide much of the desired information.

Another potential subscriber is the fire direction center (FDC) for field artillery. The FDC receives targeting information from an observer and converts it to fire commands for conventional artillery, multiple launch rocket systems, and the Advanced Tactical Missile System.[30] Combat information available to the FDC would include friendly ground positions, as well as near-real-time information on enemy location and scheme of maneuver.

For ground forces, the combat information system would go a long way toward correcting the shortfalls of the combat electronic warfare intelligence organizations. Operating from a light shelter mounted on a high mobility multipurpose wheeled vehicle the director of intelligence could maintain constant surveillance of the battlefield with regard to the enemy situation, terrain, and weather. This officer could direct the intelligence collection activities of organic assets on a near-real-time basis and refine collection requirements that would have to be forwarded to higher headquarters for tasking. The director could develop targets on a near-real-time basis and assess the battle damage assessment of the resulting fires. Finally, by comparing the friendly situation as described by the EPLRS and known positions to the signature developed by collection sensors, he could advise the commander on the operational security practices of friendly forces.[31]

As the view of sensors and range of weapons reaches over the horizon, there is an increasing need to pass information to these new long-range weapon systems. A joint program to investigate integrating operations and intelligence for targeting is the Joint Over the Horizon-Targeting (JOTH-T) test program. Near-real-time processing of all-source intelligence, particularly for use by weapons capable of striking targets beyond the range of organic sensors is a central concern for commanders from all services. While the shooter's organic sensors may be incapable of providing sufficient targeting information, the more capable intelligence sensors are often under the control of different services or national organizations.[32] JOTH-T is testing the ability of multiservice sensors and sources to provide an accurate picture for the over-the-horizon real-time targeting of long-range weapons. JOTH-T personnel are developing and testing a digital data network to carry targeting information from a

variety of joint sensors to the shooters and decision makers. Their charter is to determine whether or not:

> JOTH-T can be significantly enhanced through incremental networking of air, land, and maritime tactical databases.
>
> JOTH-T networking will provide a more complete and coherent tactical picture resulting in improved targeting accuracy and more timely targeting opportunities for all services.
>
> Tactical databases developed cooperatively by joint targeting assets using *operational* and intelligence sources can contribute more to putting weapons on target than those processed exclusively from *organic* sources.[33]

These three mission statements hit on the key mission elements of the combat information system. First, the networking of air, land, and sea systems provides synergistic effects. Second, using multiple systems enhances the accuracy and timeliness of targeting. Third, targeting must be a combination of operations and intelligence assets working together. The far-reaching goals of the program, subsequent to the joint test, are to create more effective force employment through greater concentration of force, increase tactical flexibility and situational awareness, and expand the enemy's area of vulnerability.[34] This capability will be essential in combating such mobile threats as tactical ballistic missiles that we can expect to face in the future. According to Dr Victor Reis, director of the Defense Advanced Research Projects Agency, significant progress has been made in the area of countering mobile missiles and technologies to counter them will be available by the mid-1990s.[35]

One of the most vexing problems facing aircrews today is to discriminate between friendlies and hostiles, both in the air and on the ground. Air-to-air and air-to-surface ordnance have kill capability far beyond their onboard sensor's ability to make the distinction. While onboard active and passive sensors can do rudimentary sorting, a positive system is needed to allow aircrews to employ ordnance at maximum designed range. Also, since aircrews may fly several missions a day, there will not be time to do extensive target and threat study. They will have to rely on near-real-time intelligence to update situational awareness en route to the target area. Information on fleeting targets (e.g., concentrations of enemy fighting vehicles, helicopter forward operating locations, and tactical ballistic missiles) could be passed to fighters en route to the target area, or if a precise location is known, stand-off weapons could be launched against them.

Near-real-time support to the war fighter in the Air Force could come in two ways: directly to the cockpit via a broadcast or through an off-board targeting network.

Broadcast of near-real-time combat information to the cockpit would provide mission-tailored situational data on threat and target location, identification, and priority based on filters and requirements determined by operations personnel before takeoff or during flight (fig. 16). During the early stages of the flight, the emphasis would be on maintaining situational awareness and updating

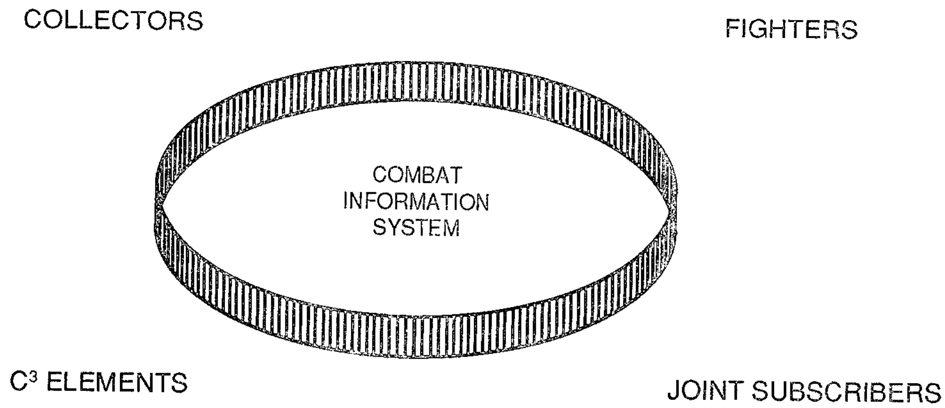


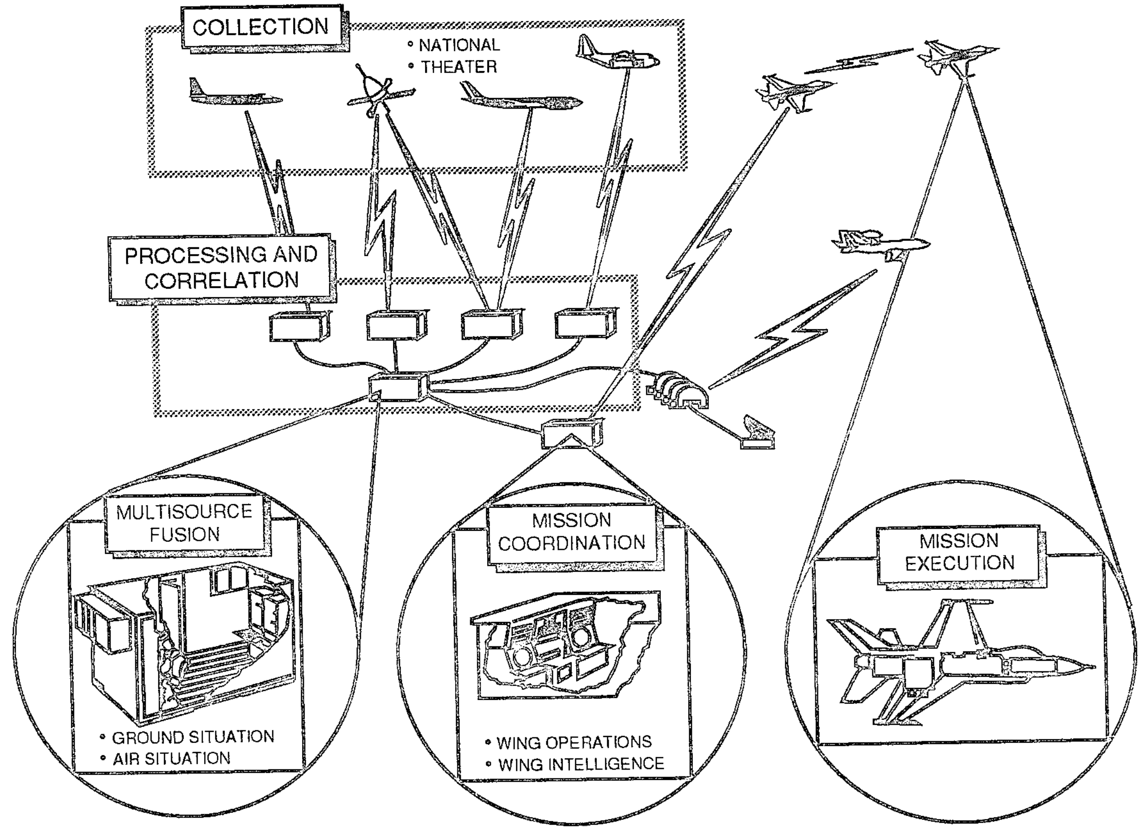
Figure 16. A Nodeless Broadcast System

orders of battle. In the target area, emphasis would swing to targeting support—updating the location, identification, and importance of targets. While egressing the area, the combat information system would act as an additional "wingman" providing threat warning and "checking six."

Relying on a broadcast system would require information correlation by the collectors with the tactical consumer merely setting filters based on individual information requirements. Correlation of onboard and off-board information can currently be accomplished by side-by-side comparisons of the information. In the future, the use of artificial intelligence and advanced onboard processors may provide an automated and integrated display with the source of the information transparent to the aircrew.

Initiatives are under way to provide this kind of off-board support to special operations aircraft. Special operations has unique combat information requirements that are not easily satisfied by onboard systems. Special operations crews need to know not only the location of traditional air defense threats but also status of military or paramilitary ground forces in their target area. Often their mission has failed if the enemy has any foreknowledge of their existence. They need to know whether they have been detected at any point along their route as well as whether they are currently being tracked by air defenses.

The second method of supporting aircrews would be via a combat information system mission coordinator at the wing or squadron level (fig. 17). An off-board targeting network, either at the force level or unit level would allow a ground-based targeting system to accomplish the correlation and targeting functions. Using the Sentinel Byte system as a baseline, near-real-time combat information would flow into the unit where an operations and/or intelligence duty officer would track and forward relevant information to the flight. The node or mission controller would be responsible for providing the best possible display of potential targets and threats and would provide threat amplification data and real-time target updates to include weather and other tactical considerations. Support to airborne aircraft could be automatic with the mission



Source: Briefing, USAF Air Warfare Center, subject: Fastball.

Figure 17. Combat Information System with Mission Coordinator

coordinator setting filters before the mission and providing a manual override during the mission. Support could also be dynamic with the tactical situation determining the amount of support provided during the mission.

The Army is currently employing this concept of targeting support using laser range finders and the Global Positioning System to determine precise location and then data linking the information to attack helicopters. A modification of this system to support SEAD operations was demonstrated at the Air Warfare Center. Other feasibility studies are planned for the future to determine the best way to support other missions. The next generation of aircraft will be stealthier and will want to limit emissions from the aircraft. Off-board sensor support via a broadcast or a mission coordinator would allow this. Maj Gen John A. Corder of the Air Warfare Center hopes that in the future off-board sensors will provide an advance look at between 40 and 60 percent of the threat and air defense environment.[36]

By following the mission on a real-time basis, the mission coordinator may be able to assess battle damage in near real time from the relative safety of the wing operations center. Mission coordinator support would need to come from the unit level because personnel and communications capability at the TACC is too limited to accommodate the thousands of individual sorties that could be generated. How many aircraft a mission coordinator could support will have to be determined through training and exercises. Depending on the timeliness and accuracy that can be achieved, the mission controller could become an electronic forward air controller, controlling battlefield air interdiction or other missions on a near-real-time basis.

Task Force Proven Force during Desert Storm used the concept of having a mission coordinator at the wing to help support the package. The six 7440th Composite Wing mission coordinators made sure aircrews understood the priorities in the daily operations order, followed the progress of the mission through the wing operations center, and ensured that all debriefs and reporting were complete. According to Brig Gen Lee A. Downer, commander of the 7440th Composite Wing, their most important function was that they "provided the commander and chief of combat plans with direct feedback on the specific successes and failures of each package as part of a constant correction process."[37] The combat information system would allow mission coordinators, duty officers in the combat operations division of the TACC, and senior leaders to see a near-real-time view of the tactical situation.

Combat aircraft returning from a mission could provide preliminary battle damage assessment information to control elements over the combat information system. In-flight reports based on onboard electro-optic or infrared systems can provide much more timely and accurate assessments of BDA than the combat cameras carried during the Vietnam era. Follow-on flights could be canceled or retargeted based on this BDA. This operations input to the battle damage assessment process is extremely critical as intelligence sensors are not always available to do near-real-time BDA. The mission coordinator should be the focal point at the wing level for intelligence data management, mission planning systems, and campaign objectives.

Characteristics of a Combat Information System

Having described the general architecture of the combat information system, we now examine some of the characteristics that are crucial to its successful implementation. The combat information system of the future must balance the requirements of speed and accuracy and provide the near-real-time intelligence/combat information to decision makers to allow them to take advantage of their multipurpose aircraft. This information will come from a "synergistic combination of a variety of penetrating unmanned aerial vehicles, standoff surveillance and target acquisition systems, and space-based sensors."[38]

The combat information system must be a joint service system combining operations and intelligence. The pace of warfare has accelerated far too much to allow us to have separate intelligence and operations communication architectures. The system must provide positive identification of hostile and friendly forces and provide indicators as to the timeliness of the information and to the system's confidence in its accuracy. It must have a standard format indicating target identification, location, and priority. It must be secure, jam resistant, and redundant with compatible voice and data link communications. The system should degrade gracefully when inputs are lost due to jamming or destruction, and it should not rely on key nodes that would cause catastrophic damage to the system if they are destroyed. Through distributed data processing and dissemination and the internetting of communication systems, the Air Force can support the tactical war fighter in the air or on the ground.

To be effective in war or contingency operations, we must train with the system on a regular basis. To do this, the combat information system must be free from the overclassification and "green door" compartmentalization problems. We need more sensitive compartmented information clearances for operations and unit intelligence personnel, and multilevel security systems to allow many levels of access from different consumers, including allied nations. We must also have a mobile system that is not tied to fixed overseas locations. We must be able to train in the US training areas and deploy to other theaters of operations that have minimal support infrastructure.

Jointness

Joint Publication 1, *Joint Warfare of the US Armed Forces,* declares that modern warfare is synonymous with joint warfare. The technology, speed of communications, and pace of events have created an environment where *"forces on land, at sea, and in the air now reinforce and complement each other more than ever before,"* and "because we operate and fight jointly, we must all learn and practice joint doctrine, tactics, techniques, and procedures"[39] (emphasis in original). The deep battle of the Army's AirLand Battle doctrine and NATO's Follow-On Forces Attack and Joint Precision Interdiction doctrine require a single, joint view of the battlefield and selection of targets. The

requirement for joint operations is not limited to a European environment, but is applicable to any conflict where targets are echeloned or dispersed over a wide area. Tactical air power provides the reach and agility, and a joint, coherent, distributed combat information system provides the initiative and synchronization necessary to succeed. This joint service coordination and cooperation must not only occur at the command and planning levels but also at the execution (tactical) level as well. The distinction between CAS, BAI, and AI, as well as the distinction between Army and Air Force targets, will continue to blur on the modern battlefield. The overwhelming success of our forces in Desert Storm was due to planners mastering "the ability to detect, identify, prioritize, and attack targets in a systematic manner."[40] The key to achieving this success was the

> organization of intelligence-gathering resources from national, joint, Service, and coalition forces and the selection of the most appropriate system to attack each target, regardless of who "owned" the target acquisition or attack system.[41]

Despite this success, the secretary of defense reported to Congress that "joint operations doctrine has outpaced the development of supporting intelligence doctrine."[42] Lt Col Bill Runge, in his monograph, *Firepower and Follow-On Forces Attack,* points out that Army and Air Force intelligence officers approach the tactical problem from different perspectives, and more representation at key nodes is required on both sides.[43]

Collection management—the determination and ranking of intelligence information collection requirements—and *asset management*—the planning, direction, and control of collection assets in support of collection management requirements—must be a joint endeavor. A critique of Desert Shield/Desert Storm by the Navy concluded that greater interoperability of intelligence systems among the services and a "joint intelligence doctrine and architecture are needed to support both joint and component commanders."[44]

As the services achieve compatibility and interoperability and develop a joint intelligence doctrine, all intelligence centers must develop a capability to support joint intelligence requirements. A series of joint intelligence centers can provide intelligence support for all the components, eliminating redundancy and ensuring unity of effort. The Joint Tactical Fusion Program is working on developing this compatibility between the Air Force enemy situation correlation element and the Army all-source analysis system.[45] This commonality is essential not only for saving development costs and proving a common view of the battlefield, but also in ensuring cross-service redundancy in case of system degradation. The intelligence field should be in the forefront of establishing joint capabilities. While each service has unique intelligence requirements, intelligence skills in the services are similar. There is a common knowledge base among such specialists as photo interpreters, linguists, and electronic intelligence analysts. Better coordination of sensor tasking and improved combat information dissemination between the services can reduce the inefficient and redundant tasking of platforms and identify targets that

are potentially of interest to all of the services. Having a common frame of reference, common data bases, and a common view of the battlefield helps to improve real-time targeting and deconfliction of individual weapons. Having operations and intelligence personnel from all services looking at the same targeting problem will improve the pairing and prioritization of weapons.

Budgetary and logistic constraints prevent deploying ground stations for such sensors as J-STARS and Rivet Joint at each node that has a requirement for the information. A combat information system that provides the information to anyone on the net eliminates the need for everyone having their own system.

Because of historic intra- and interservice rivalries, the unified commands must establish commonality/compatibility standards for systems and architectures and dictate the requirement for jointness within their intelligence centers. The Air Force Intelligence Command should be in the forefront for the Air Force in establishing standards among the various Air Force major commands.

Security

The requirement for a multilevel security system based on need to know, multiple classification levels, and categories of mission data is essential to a combat information system. Because such a system is both an operations and intelligence system, there will be a wide variety of users requiring access to elements of information on the net. Also a number of people with access to the net will have limited or no need to know certain categories of information. In the past, the requirement to safeguard sources has led to the Green Door syndrome, in which operations personnel were denied access to certain critical information because they lacked the security credentials. The ability to have a two-way flow of information between operations and intelligence while safeguarding sources and compartmented operations programs is critical to providing timely support to the tactical war fighter.

A nodeless system that has a large number of producers and consumers of combat information will help protect sources of intelligence as it will be difficult to determine which of the many potential sensors on the net provided any particular bit of information. A large number of operations and intelligence contributors to the system provides the necessary plausible cover for the sanitization of sensitive intelligence.

The enhanced multinet gateway (EMG) under development for the Air Force under Project Firestarter will allow the connection of systems operating at different security levels, but will only allow a transfer of information from one system to a system of equal or higher classification. Systems operating at a higher classification level cannot at this time transfer information to systems operating at a lower level.[46] The ability to operate both ways among systems of varying security access is critical to transferring near-real-time combat information directly from the collectors to war fighters.

Low probability of intercept technologies and such techniques as pseudonoise spread spectrum transmission, frequency hopping, jam resistance, and integral crytography are also necessary to prevent interception and exploitation of C^2 signals by enemy forces. Again, designing a distributed information system without key nodes would lessen the probability of detection and location of net subscribers.

Identification Friend or Foe

Another key requirement of any operations/intelligence system is the ability to help sort friendly from enemy forces to prevent fratricide. Fratricide is a significantly more difficult problem now than in the past. The speed of movement on and over the battlefield, the similarity in appearance of hostile and friendly weapon systems, the proliferation of "friendly" weapons systems into unfriendly hands and "hostile" systems used by current allies make identification of friend and foe a formidable task. Airspace control measures are unwieldy and air defense assessment algorithms are unreliable.

The combat information system must include elements of positive friendly identification through aircraft or ground-based IFF systems as well as positively identifying tracks as hostile through interrogation of enemy IFF systems, noncooperative target recognition systems, and source of origin determination (e.g., if an aircraft took off from an enemy airfield, it is an enemy). There are already efforts underway to create a joint operations network within some mission areas to prevent fratricide.

The Joint Air Defense Operations/Joint Engagement Zone (JADO/JEZ) test group is working to establish an environment where operations and intelligence personnel work together to provide near-real-time intelligence and targeting information to airborne and ground-based air defenses. This is a capability that Lt Gen Charles A. Horner, air component commander of coalition forces during Desert Storm, called "critical during future combat operations," and a concept that "can be applied across the full spectrum of US forces and may be expanded to provide an effective way for our forces to interface with those of host nations."[47]

Timeliness and Accuracy Indicators

The speed of modern warfare has placed an unprecedented importance on the timeliness of intelligence and combat information. Often, information that is days or even hours old is of absolutely no value, and in fact may confuse the issue more than help it. Therefore, the war fighter must have an indication of the timeliness of the information. For targets such as airfields or industrial complexes, imagery or other intelligence that is several days old may be perfectly adequate. On the other hand, information on an armored column may be obsolete within a matter of minutes. Table 4 demonstrates typical "lifetimes" of a variety of targets. The lifetime of a target is defined as the time within which there is a 90 percent probability that the target is in the footprint of an area munition or within the field of view of a precision weapon.

Table 4

Lifetimes of Targets

Target	*Time in Minutes*
Individual	1
Tanks	10
Mobile Surface-To-Air Missile	10
Aircraft (Parked)	10
Company	20
Battalion	45
Bridge (Temporary)	240
Airfields (Forward Location)	240

Source: Adapted from Michael F. Poore, "Integrating New Technology Into the TAC RECCE Cycle," *Journal of Electronic Defense*, May 1986, 55.

There is a great deal of difference in the timeliness of the various reconnaissance and surveillance platforms. The combat information system must provide the war fighter an indication of how current the information is so that he can personally weigh the importance of the information.

Another concern about combat information is the confidence level in its accuracy. Each intelligence discipline and collector has different accuracy levels depending on dwell time on the target and corroborating evidence. Signals intelligence information often gives very timely information, but only a relatively imprecise location of the target. Imagery intelligence gives precise information, but is difficult to deliver to the war fighter in near real time. Human intelligence can provide significant details, but generally is not timely. Table 5 reflects some of the comparative strengths between the intelligence disciplines.

Each consumer of combat information (in the command post, control center, or cockpit) has individual timeliness and accuracy requirements. Putting accuracy and timeliness indicators on the information allows the consumer to decide whether the information is useful or not.

Table 5

Comparative Intelligence Capabilities

	Imagery Intelligence	*Signals Intelligence*	*Human Intelligence*
Accuracy	50–2,000 Feet	1–10 Miles	Inches–Miles
Timeliness	Hours–Days	Minutes–Hours	Days–Months
Detail	Inches–Feet	Emitter Type	Variable
Penetration	Night/Clouds	Night/Clouds	Inside Buildings

Source: Norman B. Nill, *Image Intelligence—Systems and Techniques,* ESD-TR-84-191 (Bedford, Mass.: Mitre Corporation, 1984), 89.

Formats

With a system that is used by all services in accomplishing a wide variety of missions, it is essential to establish standard formats for target identification,

location, and priority. While there has been a great deal of standardization within the various intelligence disciplines, there is little standardization between intelligence disciplines or between the various services. This lack requires the intelligence analyst to have a working knowledge of the unique requirements of each discipline. It increases the difficulty of automated sorting and dissemination of time-sensitive information due to the requirement to translate the raw data into meaningful information. It also hampers the correlation of information from the various intelligence disciplines to produce a fused intelligence product. Standardized data elements, distributed data base management, and expert systems will help streamline the flow of information and provide usable information in a more timely, user friendly format.

Likewise there must be common terminology and mapping between the various components as they develop the overall targeting plan. The Army and Air Force typically use different maps for tactical use that can induce errors of hundreds or thousands of feet, especially when relying on inertial navigation systems and attacking over-the-horizon targets.[48] It is also important to have a standard system of labeling the priorities of targets and threats so as to ensure no misunderstandings between services in the heat of combat.

Communications Requirements

Communications is possibly the most critical component of the combat information system. Communications for the combat information system must be robust, secure, jam resistant, and redundant. While the sophisticated communication systems of today are impressive, conventional message traffic as well as the demand for digitized imagery from processing centers in the US and Europe inundated the Defense Satellite Communications System during Desert Storm.[49] The demand for high volumes of combat information at lower echelons is also increasing dramatically. The communication system must also overcome the line-of-sight communications problems that plague low-flying aircraft or systems attacking over-the-horizon targets. Installing a series of radio relays on board currently flying aircraft (AWACS, J-STARS, Rivet Joint), using a dedicated radio relay platform such as the Condor endurance unmanned aerial vehicle, or deploying a series of tactical satellites to augment current satellite communication capabilities can overcome this problem. The Air Force is already studying an airborne imagery transmission program that would receive transmissions from a reconnaissance platform and relay the data to a Joint Service Imagery Processing System (JSIPS) terminal.[50] The Air Force should expand this program to encompass more collection systems and intelligence disciplines.

A variety of data links exist that could be the basis of the communication system. The Air Force and Army are deploying the Joint Tactical Information Distribution System (JTIDS), which shows the most promise as the host communication system. JTIDS operates on the principle of time-sharing randomly hopped frequencies among subscribers on the communications net. Jamming resistance is accomplished using spread spectrum transmission

techniques that force the enemy to increase the required jamming power by a factor of several thousand. JTIDS uses pulse-by-pulse frequency hopping to distribute data over a several hundred megahertz bandwidth, and it uses an error correction code that permits recognition of the information content of a message even if up to 50 percent of the data is lost in transmission.[51]

JTIDS is a time-division, multiple-access system. It is a nodeless system that does not rely on communication centers or key nodes to pass information. Each subscriber has time slots for transmitting and is able to receive at all other times. The number of slots allotted is based on the communication requirements (i.e., a command and control node, intelligence collector, flight lead, and wingman all have different transmission requirements).[52] The destruction or jamming of any node on the net degrades, but does not destroy the integrity and effectiveness of the overall net.

In late 1991 the Army, Air Force, and Navy successfully conducted a test with fighters, AWACS, ships, and ground stations passing friendly and hostile track information. During the test, non-JTIDS equipped Navy F-14s were able to pass track information to a Navy E-2C, which in turn reformatted the information and sent it out on the net. Cost has been a major stumbling block in the acquisition of the system.[53]

The Multimission Advanced Tactical Terminal is an advanced radio receiver in development that will have imbedded cryptomaterial and the capability to receive and display broadcast information at the Secret level from the following sources:

1. Tactical Digital Information Exchange Subsystem-B (TADIXS-B)—near-real-time electronic intelligence (ELINT)
2. Tactical Receive Equipment and Related Applications—near-real-time ELINT
3. Fleet Satellite Broadcast—Situational awareness
4. Officer in Tactical Command Information Exchange Subsystem—Order of Battle/C^2
5. Tactical Digital Information Link-J—Tactical Information Broadcast Service
6. Secure voice and Have Quick II.[54]

The modular control equipment being deployed by the Air Force as an air traffic and air defense control center has data link capability with E-3 Sentry and E-2C Hawkeye airborne warning and control aircraft and with Patriot and Hawk air defense missile systems. It will have JTIDS capability with the first preplanned improvement cycle.[55]

The Navy has a new data link in some of their F-14s that shows the locations of the other F-14s in the flight and their respective radar targets. The radar intercept officer in the F-14 can display an enemy track, its heading and airspeed, or his own wingman's fuel and armament status without using a radio.[56]

One of the critical advantages of this type of system is that it provides information on demand without increasing the work load of the aircrew.

There is an abundance of onboard and off-board inputs to the crew's situational awareness, and sensory overload becomes a real problem at times. Since the system provides information graphically on a continuous basis, crew members can get updates as time and work load permit and are alerted only when they receive a time sensitive threat warning or target update.

Survivability

One of our key objectives in attacking an enemy is to disrupt or destroy his command and control system. We can anticipate that our own command and control would also be subject to attack. Therefore, we must protect our C^3I systems and design them to survive and degrade gracefully. When the enemy degrades or destroys parts of the system, we should feel the overall impact in small incremental steps and not as a catastrophic systemwide failure. A study on command and control in the twenty-first century concluded that C^3I nodes will have to be physically dispersed and functionally distributed for survivability. A building-block approach using modular elements will be required to support deployable, incremental levels of support.[57] To accomplish this, the combat information system must not have critical nodes in intelligence collection, command and control, or execution. Data bases and processing capabilities must be redundant with the communication flow throughout the system distributed so that all participants share common data bases and a common perspective of the battlefield. The execution elements of the TACS (such as the CRC and ASOC) must be able to receive sensor information directly and be able to use it on a near-real-time basis without the benefit or delays of correlation and fusion by the TACC or another intelligence center. The communication architecture that ties the whole system together must be redundant and robust, and automatically reroute communications around severed lines.

Train Like You Fight

If a combat information system is to work in combat, all the key elements such as the collectors, command and control nodes, and aircrews must train with the system during peacetime to ensure procedures are developed, technical problems resolved, and confidence in the system established before the start of hostilities. The Air Force White Paper, *Air Force Performance in Desert Storm,* stated that one area for improvement "involved the use of systems which the military cannot use during peacetime training—to use them would compromise their capabilities."[58] If the US does not develop a way of training with these systems, then it almost inevitably cannot use their capabilities fully in war. There is evidence that some units did not use or connect some intelligence systems available during Desert Storm because personnel were not familiar with their operations and capabilities. The tremendous investment in these sophisticated systems was wasted for these units because they did not receive any benefit from their advanced capabilities.

Mobility

Because of the requirement to respond to rapidly deteriorating political situations throughout the world, any combat information system must be extremely mobile. In 1983 the US military had four days to plan, deploy, and execute the rescue of US citizens in Grenada. Initial forces deployed to Saudi Arabia in support of Desert Shield had similar time constraints.[59]

Air Force intelligence ground processing centers must become more mobile and multipurpose. With the decreasing threat in Europe and the increasing likelihood of US involvement in regional conflicts, the Air Force cannot afford to be tied to hardened fixed sites such as those in Europe and Korea. Future intelligence collection and processing centers must be able to travel with the mobile tactical air control centers under development. The intelligence collection and processing centers must be able to set up quickly and must be able to communicate with national intelligence centers, tactical collection aircraft, and command and control nodes. Collection and processing centers must be downsized and multidiscipline, allowing the deployment of a package tailored to the size of the conflict. They must not be large, lucrative targets that the enemy can destroy, and thus eliminate all intelligence capability for the commander. Desert Storm demonstrated the futility of relying on hardened shelters to ensure survivability of C^3I nodes. Technology advances in the guidance and warheads of precision munitions have redefined what a "hardened" shelter is.

Efforts are under way in the Air Force to start downsizing these centers beginning with the repackaging and integration of the TR-1 ground station (TRIGS) as the contingency airborne reconnaissance system. The TR-1 and U-2 programs have been combined and all the aircraft designated U-2s. Two deployable ground stations are under development that will process, exploit, and disseminate products from the U-2.[60] The ability to process information from the follow-on tactical reconnaissance system and national imagery systems will be added by including JSIPS processors by 1996. The TRIGS system will provide the collection and processing centers with near-real-time SIGINT and IMINT, multisource intelligence correlation capabilities, multilevel security in mission control, and access to national level SIGINT inputs. From the JSIPS the centers will get national imagery, real-time tactical imagery, an imagery exploitation and reporting system, a secondary imagery dissemination system, and a tactically deployable ground station.[61]

Interoperability

In a study called *Decision Aiding Technology for Tactical Battle Management* the Air Force Studies Board found that the Air Force Systems Command has been unable to meet in a timely way the tactical battle management needs of the operational commands, that the operational commands are developing their own systems to support battle management, and that there are Army, Navy, and Defense Advanced Research Projects Agency research and development efforts that could contribute directly to Air Force needs.[62]

Incorporating technologies and architectures from these programs could go a long way toward standardizing DOD systems. Finally, the operation and presentation of systems between the various nodes must be sufficiently similar to require a minimum of training of personnel cross flowing from one node to another.

For any system to be responsive to the needs of the combat commander, it must be compatible with other Air Force systems and, to the absolute maximum possible, with joint and allied systems. There must be standards within the intelligence community to ensure commonality and compatibility of sensors, data links, and ground processing systems as well as compatibility with tactical battle management C^3 systems.

The Air Force is structured functionally (operations, intelligence, logistics, etc.) with data automation systems designed to support these functional areas from the Air Staff to the unit level. These vertical data automation systems "stovepipe" information in the same way that various intelligence systems stovepipe information. The various functional areas have been reluctant to allow other areas to access their data.[63] The wing command and control system at the unit level is just now starting to provide a netting of operations, intelligence, weather, maintenance, and combat support functions together.

There is currently no Air Force-level office charged with establishing standards or ensuring compatibility of tactical battle management systems.[64] The Headquarters Air Combat Command Directorate of Integration has integration responsibilities, but has no authority to speak for the tactical air forces. The result is that each major command has developed its own tactical battle management systems.[65] Within the Air Staff, the deputy director for intelligence systems support and the commander of the Air Force Intelligence Command should champion the establishment of these standards within the intelligence community.

Equipment compatibility does not ensure system compatibility. Policies, procedures, and training are required to provide operators and commanders confidence in the capabilities and usefulness of the system.

In addition to striving for compatibility and commonality within the Department of Defense, efforts should be made to minimize compatibility problems with our allies. Addressing a working group on Intelligence Concept of Operations for Composite Wings, Col M. G. Ewig, Tactical Air Command's director of intelligence systems, stated that "fighting as part of a coalition will be the wave of the future. . . . This is contrary to the way intelligence has done business in the past."[66]

Within NATO, a concept of Battlefield Information Collection and Exploitation Systems (BICES) is under development. Historically within NATO, intelligence collection, processing, and dissemination has been a national responsibility. This has led to a fragmented intelligence structure and a lack of automated means of providing timely, comprehensive intelligence. BICES is an umbrella program to ensure that development of collection, processing, and dissemination systems will meet NATO standards.[67]

Currently efforts are under way to field a NATO version of the Joint Tactical Information Distribution System class 2 terminal called the Multifunction Information Distribution System.[68] There is also research into developing a "reformatter" that will allow the Joint Service Imagery Processing System to process imagery from allied systems. The Defense Intelligence Agency (DIA) has a project office to support the goals of BICES, but there are many stumbling blocks including technology transfer policies, pressure for countries to purchase domestically built systems, and security restrictions on the releasability of intelligence, but efforts must continue to improve intelligence cooperation in a combined environment.[69] Even after the DIA resolves all the sensor, communication, security, and technical problems, it will have to develop procedures for using this near-real-time combat information system in a multinational coalition.

Problems of the Composite Wing

The Mountain Home AFB, Idaho, intervention wing and the Pope AFB, North Carolina, battlefield attack wing present some unique problems and opportunities for providing near-real-time intelligence to the tactical war fighter. When a composite wing is performing a forced entry into a hostile environment or a peacetime contingency operation directly from home station within the US, it will require an intelligence structure similar in capabilities to the tactical air control center of today. Currently, wings do not have the manpower, expertise, equipment, or communications connections to the national level intelligence agencies necessary to act as an independent task force. The Site Activation Task Force for the beddown of the composite wing at Mountain Home AFB has identified a requirement for six Sentinel Byte systems, six Constant Source systems, two intra-theater imagery transmission systems, and four tactical digital facsimiles as well as in-garrison and deployable local area networks to provide logistic, operations, and intelligence information to all affected organizations.[70]

Typical tactical wing intelligence shops emphasize distribution of processed intelligence to the commander and aircrews via briefing and target materials received from higher echelons. They are not well versed in collection management and intelligence analysis. They are manned to support single mission wings that have set priorities for threat information. (An F-15 air-to-air wing has a different intelligence focus than an F-111 interdiction wing, an A-10 close-air-support wing, or an F-4G defense suppression wing.)

The composite wing concept calls for a marginal increase in intelligence personnel, but not nearly what will be required if they are to serve as envisioned as the "JTF [Joint Task Force] or lead air component element of a larger force . . . capable of autonomous, self-sustained, 24 hour conventional operations for up to 7 days . . . [and] capable of executing mission type orders from [the] NCA/CINC/JFC [National Command Authority/Commander-in-Chief/Joint

Force Commander]."[71] The 366th Wing will have to function as a mini air control center, and its intelligence shop will have to perform the collection management, targeting, intelligence production, current situation, and target analysis functions on a 24-hour basis with only 44 people including personnel for supervisory and administrative functions.

The composite wings as currently envisioned do not have a dedicated reconnaissance/surveillance processing capability or ties to the national systems in terms of collection management or receiving intelligence feeds from the national systems. They must take maximum advantage of any reconnaissance capability that exists in-theater, whether from onboard sensors of unit aircraft or joint service reconnaissance systems integral to the initial deploying forces.

The 7440th Composite Wing that operated from Incirlik AB, Turkey, is an example of how the composite wings of the future should work, but it does not present a fair comparison. Brig Gen Lee A. Downer, commander of the 7440th Composite Wing and Task Force Proven Force had several advantages that future composite wing commanders may not have. First, he was given access to all personnel resources within United States Air Forces in Europe (USAFE) and selected what he called the "superstars" from all over Europe to fill key positions as well as the best company- and field-grade officers to fill out the rest of his staff. They were supported by the well-established NATO intelligence and communications infrastructure. The intelligence staff at Incirlik received "information and imagery filtered for Proven Force operations" and the "intelligence communications systems proved invaluable in efficiently moving much of the data from the intelligence center to the wing," but even with all this support from the NATO infrastructure, the crews were still dissatisfied with the intelligence support they received.[72] Proven Force (as well as most of the Desert Storm forces) had two other tremendous advantages that composite wings of the future cannot anticipate—they faced a relatively stationary enemy with many fixed targets, and the Iraqis did not attack our intelligence infrastructure physically or electronically.

Although US Air Forces, Central Command gave Joint Task Force Proven Force a target list, the force built its own tactical air control center, developed its own air campaign, wrote its own air tasking orders, and coordinated its own off-station support (e.g., RC-135s from Hellenikon AB, Greece).[73] This was a challenge that any homogeneous or composite wing would find daunting without the extensive increase in personnel, infrastructure, and outside support General Downer enjoyed.

Summary

The combat information system of tomorrow should provide decision makers at all levels with critical time-sensitive intelligence and operations information. The combat information system will improve interoperability of sensors, communications, intelligence processing, and data displays. It will allow better sharing of information among the services that will lead to more

accurate and timely targeting information, new targeting opportunities, and a greater likelihood of weapons on target. This in turn will lead to greater concentration of firepower, increased flexibility in prosecuting the deep battle, and improved situational awareness at all echelons in all services.[74] The system must be joint service, have two-way multilevel security, standard terminology and formats, robust and survivable communications, and the ability to train and exercise in peacetime and to deploy rapidly anywhere in the world in support of contingencies.

Headquarters USAF, the Air Force Intelligence Command, and the Air Combat Command Directorate of Intelligence systems must work closely together to establish and enforce standards. Development of the system should be evolutionary under the umbrella of the Contingency TACS Advanced Planning System, should maximize currently fielded systems, and should mandate compatibility of new systems. However, with surveillance and communication capabilities that literally let the White House see the near-real-time tactical situation, there will be a strong temptation for senior leaders to involve themselves in minor operational details. Commanders across all operational echelons must discipline themselves to look at the long-term objectives and not to become reactive to the short-term successes and failures that are observed in near-real-time. Despite this problem, the combat information must keep all levels connected, otherwise as British theorist Maj Gen J. F. C. Fuller noted:

> If intercommunications between events in front and ideas behind are not maintained, then two battles will be fought—a mythical headquarters battle and an actual front-line one, in which case the real enemy is to be found in our own headquarters.[75]

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Chapter 6

Summary and Conclusion

Victory smiles upon those who anticipate the changes in the character of war, not upon those who wait to adapt themselves after the changes occur.

—Giulio Douhet

Throughout history commanders have desired timely intelligence. Today, official Air Force doctrine stipulates that the "effective and efficient use of aerospace power depends on accurate and timely intelligence." AFR 200-15, *Aerospace Intelligence Functional Doctrine,* emphasizes that intelligence is worthless if received after the opportunity to use it has passed or an irreversible decision has been made.[1]

The nonlinear battlefield of the future, whether in a conventional operation, contingency operation, or low-intensity conflict, requires a revitalized tactical intelligence or combat information system. The combat information system must take advantage of the technology available in the areas of sensors, communications, and intelligence processing.

The sequential intelligence cycle and the organization for disseminating intelligence and combat information are outdated. Air Force Chief of Staff General McPeak has stated that our current method of collecting intelligence and tasking air power has "shackled" our air forces and "hitched our jets to a hot air balloon."[2] Technology has enabled us to develop surveillance systems that maintain a constant watch over the battlefield versus reconnaissance systems that are tied to time-consuming and logistics-intensive ground processing centers. This ability to maintain surveillance of the battlefield has led to the desire to do near-real-time targeting of time-sensitive targets using sophisticated long-range precision weapons. The RC-135 Rivet Joint and the E-8 Joint Surveillance Target Attack Radar System have demonstrated the ability to provide near-real-time targeting information to the war fighter. The Contingency Airborne Reconnaissance System (CARS) under development will provide the capability to cross-cue sensors on a common platform and provide producer correlated combat information on a near-real-time basis.

Only in time of active warfare are reconnaissance methods and forces afforded an equal priority with fighter and bomber forces. Our entrances into World War I, World War II, Korea, Vietnam, and even Desert Storm have been marked by inadequate aerial reconnaissance capability. This resulted in a series of catch-up efforts as we realized the obsolescence of our equipment, procedures, and methods.[3] The mercifully short duration of Desert Shield/ Desert Storm led to the recognition of many problems and jury-rigged solutions,

but no new long-term solution to our shortfall of near-real-time intelligence/combat information. In the past, shortsightedness about maintaining a robust and capable Air Force tactical reconnaissance system led to unnecessary losses. As Air Force reconnaissance has become more centralized and less responsive to other service requests for support, these services have developed organic aerial reconnaissance capabilities to decrease their dependence on Air Force systems.

The problem today is not a lack of technology, but inadequate management of tactical intelligence requirements. Our strategic emphasis has resulted in an emaciated tactical reconnaissance capability and stovepiped systems and architectures within the various intelligence disciplines as well as in the intelligence community as a whole. Within the confines of theater warfare, the emphasis has been on supporting the operational level of war. Tactical support to the war fighter is trickle-down support and not dedicated support.

Interoperability is still a major problem, with many Air Force intelligence systems not compatible even within the same intelligence discipline. There is little joint service cooperation in collection, processing, or dissemination of tactical information. Three major lessons learned for intelligence from Desert Storm were that joint intelligence doctrine must be refined, all services and agencies must deploy with compatible intelligence dissemination and communications systems, and joint operations centers must be staffed and equipped to handle the tremendous volume of raw and processed intelligence data generated by modern intelligence systems.[4]

Intelligence must become more concerned with both the detection and identification functions. With the current speed of maneuver, the geographically dispersed nonlinear battlefield, and an increasing emphasis on coalition warfare, the military must implement a system of positively identifying both hostile and friendly forces.

The conflicts we may have to support in the future span the continuum from counterterrorism/counterdrug operations to one-time interventions, such as operations Urgent Fury in Grenada or Just Cause in Panama, all the way up to major regional confrontations such as Desert Storm. The threat environment we can expect to face will be more lethal, mobile, and dense, and we will have minimal infrastructure to support anticipated 24-hour operations. We will enter the fray with a smaller force structure, multirole aircraft, and long-range precision guided munitions.

To take maximum advantage of our capabilities, we must integrate our command, control, communications, and intelligence systems through better near-real-time tasking of reconnaissance/surveillance sensors and cross-cueing and fusion of combat information to support the tactical war fighter. This should be done through a joint service, operations/intelligence network that combines operations data, such as friendly position and identification, with intelligence information, such as threat and targeting information. A nodeless communications architecture, as already exists with the Enhanced Position Location Reporting System and the Joint Tactical Information Distribution System, fed by near-real-time updates from such sensor broadcasts as Constant

Source and the Tactical Information Broadcast Service will provide the operational security, robustness, and interconnectivity necessary. The combat information system must be mobile and allow modular components to be added to the system depending on the theater infrastructure and level of forces. All services must be able to contribute sensor data, get combat information from the system, and be able to train with the system during peacetime exercises.

Programs are under way that support this kind of combat information system for certain mission areas. The Joint Air Defense Operations/Joint Engagement Zone program is looking at this type of system to support air defense operations, the Joint Over the Horizon-Targeting program is looking at this concept to support long-range joint interdiction targeting, and the Real Time Intelligence to the Cockpit program is looking at technical aspects of providing targeting information to support the suppression of enemy air defenses mission. The biggest shortfall is in support to close air support and battlefield air interdiction. These are the areas that require the greatest joint service coordination and which have the greatest potential for fratricide. The vacuum caused by the cancellation of the Ground Attack Control Center needs a combat information system capability to support the rapid maneuver warfare of the future.

The combat information system will tie these programs together, help ensure interoperability of current and future communications and intelligence systems, and help ensure the capability to fight future conflicts as a joint team. By combining information from all of the intelligence disciplines, from all the involved services, and from operations as well as intelligence sources, we can allow tactical war fighters at all echelons to share a common view of the battlefield and to jointly target the highest priority threats with the appropriate weapon system.

Notes

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Glossary

air reconnaissance—(DOD). The acquisition of intelligence information by employing visual observation and/or sensors in air vehicles.

air support operations center—(DOD, NATO). An agency of a tactical air control system collocated with a corps headquarters or an appropriate land force headquarters, which coordinates and directs close air support and other tactical air support.

area of influence—(DOD, NATO). A geographical area wherein a commander is directly capable of influencing operations by maneuver or fire support systems normally under his command or control.

area of interest—(DOD, NATO). That area of concern to the commander, including the area of influence, areas adjacent thereto, and extending into enemy territory to the objectives of current or planned operations. This area also includes areas occupied by enemy forces who could jeopardize the accomplishment of the mission.

bomb damage assessment—(DOD). The determination of the effect of all air attacks on targets (e.g., bombs, rockets, or strafing).

collection requirement—(DOD). An established intelligence need considered in the allocation of intelligence resources to fulfill the essential elements of information and other intelligence needs of a commander.

combat information—(DOD). Unevaluated data, gathered by or provided directly to the tactical commander which, due to its highly perishable nature or the criticality of the situation, cannot be processed into tactical intelligence in time to satisfy the user's tactical intelligence requirements.

combat intelligence—(DOD). That knowledge of the enemy, weather, and geographical features required by a commander in the planning and conduct of combat operations.

communications intelligence—(DOD). Technical and intelligence information derived from foreign communications by other than the intended recipients. Also called COMINT.

control and reporting center—(DOD). An element of the US Air Force tactical air control system, subordinate to the tactical air control center, from which radar control and warning operations are conducted within its area of responsibility.

correlation—(DOD, NATO). In air defense, the determination that an aircraft appearing on a radar scope, on a plotting board, or visually is the same vehicle as identified by information from another source. For other purposes, the determination that separate pieces of intelligence or information are really the same event.

electronics intelligence—(DOD). Technical and intelligence information derived from foreign noncommunications electromagnetic radiations emanating from other than nuclear detonations or radioactive sources. Also called ELINT.

essential elements of information—(DOD). The critical items of information regarding the enemy and environment needed by the commander by a particular time to relate with other available information and intelligence to assist in reaching a logical decision.

evaluation—(DOD). In intelligence usage, appraisal of an item of information in terms of credibility, reliability, pertinency, and accuracy.

fire support coordination line—(DOD, NATO). A line established by the appropriate ground commander to ensure coordination of fire not under his control but which may affect current tactical operations. Supporting elements may attack targets forward of the fire support coordination line, without prior coordination of the ground force commander, provided the attack will not produce adverse surface effects on, or to the rear of the line. Attacks against targets behind this line must be coordinated with the appropriate ground force commander.

fusion—(DOD). Information from many collection sources is combined, evaluated, and analyzed to produce intelligence useful for decision making (AFR 200-15).

human intelligence—(DOD, NATO). A category of intelligence derived from information collected and provided by human sources. Also called HUMINT.

identification, friend or foe—(DOD, NATO). A system using electromagnetic transmissions to which equipment carried by friendly forces automatically responds, for example, by emitting pulses, thereby distinguishing themselves from enemy forces. Also called IFF.

imagery exploitation—(DOD, NATO). The cycle of processing and printing imagery to the positive or negative state, assembly into imagery packs, identification, interpretation, mensuration, information extraction, the preparation of reports, and the dissemination of information.

imagery intelligence—(DOD). Intelligence information derived from the exploitation of collection by visual photography, infrared sensors, lasers, electro-optics and radar sensors such as synthetic aperture radar wherein

images of objects are reproduced optically on film, electronic display devices or other media. Also called IMINT.

information—(DOD). In intelligence usage, unevaluated material of every description that may be used in the production of intelligence.

intelligence—(DOD). The product resulting from the processing of the collection, processing, integration, analysis, evaluation, and interpretation of available information concerning foreign countries or areas. The term is also applied to the activity which results in the product and to the organizations engaged in such activity.

mission type order—(DOD). 1. An order issued to a lower unit that includes the accomplishment of the total mission assigned to the higher headquarters. 2. An order to a unit to perform a mission without specifying how it is to be accomplished.

near real time—(DOD). Delay caused by the automated processing and display of an event and the reception of the data at some other location.

real time—(DOD). The absence of delay, except for the time required for the transmission by electromagnetic energy, between the occurrence of an event or the transmission of data, and the knowledge of the event, or reception of the data at some other location.

reconnaissance—(DOD, NATO). A mission undertaken to obtain, by visual observation or other detection methods, information about the activities and resources of an enemy or potential, or to secure data concerning the meteorological, hydrographic, or geographic characteristics of a particular area.

sensitive compartmented information—(DOD). All information and materials bearing special community controls indicating restricted handling within present and future community intelligence collection programs and their end products for which the community systems of compartmentation have been or will be formally established. Also called SCI.

signals intelligence—(DOD). A category of intelligence information comprising either individual or in combination all communications intelligence, electronics intelligence, and foreign instrumentation signals intelligence, however transmitted. Also called SIGINT.

signals intelligence operational tasking authority—(DOD). A military commander's authority to operationally direct and levy signals intelligence (SIGINT) requirements on the designated SIGINT resources. It includes the authority to deploy and redeploy all or part of the SIGINT resources for which SIGINT operational tasking authority has been delegated. Also called SOTA.

surveillance—(DOD, NATO). The systematic observation of aerospace, surface, or subsurface areas, places, persons, or things, by visual, aural, electronic, photographic, or other means.

tactical intelligence—(DOD, NATO). Intelligence which is required for the planning and conduct of tactical operations. (DOD) Tactical intelligence and strategic intelligence differ primarily in level of application but may also vary in terms of scope and detail.

time sensitive targets—(DOD). Those targets requiring immediate response because they pose (or soon will pose) a clear and present danger to friendly forces or are highly lucrative, fleeting targets of opportunity.

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We welcome your comments on this research report or opinions on the subject matter. Mail them to: CADRE/RI, 401 Chennault Circle, Maxwell AFB AL 36112-6428.

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Marshall